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Supreme Court of the United States

OCTOBER TERM, 1935

IN EQUITY.

No. 11, Original

THE STATE OF WASHINGTON, COMPLAINANT,

vs.

THE STATE OF OREGON.

NARRATIVE OF TESTIMONY PREPARED BY THE STATE OF WASHINGTON.

FILED OCTOBER 14, 1935.

No. 17 ORIGINAL

IN THE

SUPREME COURT

OF THE

UNITED STATES

OCTOBER TERM, 1930

THE STATE OF WASHINGTON,
Complainant,

v.

THE STATE OF OREGON,
Defendant.

BRIEF FOR THE STATE OF WASHINGTON

NARRATION OF TESTIMONY

BEFORE HON. WILLIAM W. RAY, SPECIAL MASTER.

STATE PRINTING PLANT, OLYMPIA, WASH.

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3. List of all exhibits received in evidence is set out in this brief beginning at page 251.

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List of names of witnesses whose testimony is not narrated in this brief. These are all witnesses for the State of Oregon. Numerals in parentheses refer to pages of reporter's transcript where the testimony is found.

Babcock, D. H. (812-819); Bookout, Lloyd (837); Bowman, Orin (510-516); Criger, W. E. O. (702-712); Eiffert, Charles (822-831); Fee, James A. (630-634); Harris, Clifford B. (841-845); Herman, W. H. P. (846-850); Herr, C. E. (748-756); Karker, C. J. (805-811); Knopf, George (742); Schwald, Chas. (584-592); Whiting, H. V. (582).

TESTIMONY

Submitted in pages herein following is the substance of testimony deemed material to the contentions of the Complainant in the instant case. Numerals in parentheses in the narration of testimony refer to the page of the reporter's transcript where the testimony begins.

MARVIN CHASE, whose qualifications were admitted, testified in behalf of the State of Washington, on direct examination, for the purpose of qualifying Washington's Exhibits Nos. 20 to 23 inclusive, for admission in evidence (17-51, 148):

My name is Marvin Chase, a resident of the State of Washington. I have had over fifty years practical experience as an engineer. I have examined Mr. Youngs' soil map (Washington Exhibit No. 15) and have endeavored to estimate the acreages of the various irrigated areas classified in that map to type of soil, having in mind also the rights which are set out in the various decrees of the water rights in the two states, which decrees are in evidence in this hearing at this time. I have made a tabulation of those acreages. One tabulation is by sections (Washington Exhibit No. 20), that is, I have located as best I could the areas of the different classifications of soil shown on this map according to township, section and range in the State of Washington. I have also done the same thing for the State of Oregon (Washington Exhibit No. 21). In addition I have also estimated the areas of these lands according to the soil classification of this map by the priorities of rights shown in the several decrees for the area in the State of Washington (Washington Exhibit No. 22) and also the area in the State of Ore-

gon (Washington Exhibit No. 23). I have included only the lands that are what we have termed related lands, lands that are related to each other on this stream system so far as the water rights are concerned. I arrived at the estimates of these acreages by perimetering the area shown on the map.

(148) On cross-examination by Mr. Cochran, counsel for the State of Oregon, Mr. Chase testified: In making the tabulation of acreages as shown in Exhibit 23, I used the soil map Exhibit 15 together with the Oregon decree and permits. In the west half of the southwest of the northwest of Section 21, Township 5 North, Range 36 on the soil map, there are indicated two classes of soil, types 2 B and 1. In my tabulation of priorities for Oregon Exhibit 23 under date of 1872 I class 3½ acres as 2 B. I distinguished as to where that particular priority would apply under those two classifications in this way. I first made a transparent section map, cut up into smaller legal subdivisions than what the map is, into sixteenths, and then placed it over this map here, and with the aid of people, or one or two who were familiar with the location of that particular piece of land, we in that way found as near as possible where that particular tract was.

Washington Exhibit No. 1, the Oregon decree, page 112, under the name of Leslie Demaris, Proof 162, combines 1872 as 3½ acres, 1890 as 6½ acres, 1906 as 9½ acres into one so that they can use all of those priorities upon the same land. Consequently when you segregate one priority for one particular piece of soil, picking out the very small areas as this area is, it would be the best

average that would be possible to get, of those small tracts. On larger tracts it comes nearer being absolutely accurate, as near accurate as possible to fit the map to the ground on irregular areas. There isn't any way that I can tell which type of soil comes under any particular priority except to know the land. On these particular lands, I have been over them many times. As to just where they lie exactly I do not know, and I doubt if anyone does. It is impossible to make a hundred per cent soil classification of the lands on the ground. There are only three types of the six or seven given on the map, in this particular section. I gave the early priority '872 as a 2B classification. Under 1890 it gives it here as 3½ acres and ten acres is shown. In both of these cases the amount of land taken from his ownership with the priority dates are divided as nearly as is possible between the two. Under 1890 I gave the 6½ acres as Class 3. I believe there is Class 3 in that particular part. Here is Class 3. It goes up into the Northwest of the Northwest. I have classified, under 1906, 9½ acres as Class 3 in the same section. It would be an average, which is all that is possible to get. My method of determining that was to make an average and distribute it between the three priorities which that man had upon that particular land. With the soil map as the one which we used, together with a knowledge of the land, it was done as near accurate as it could possibly be with those irregular tracts and the irregular way in which the soil classification is made there. Here is a piece of land having three priorities and two classifications (of soil). In place of dividing one priority between the two classifications, I put all of one classification

under one priority and then another classification under another. The older priorities along the stream were given the better type of soil, where it was impossible to distinguish from them owing to the fact that it is usual for one to develop the better land first. With a proper regulation and proper use of water, the beneficial use of it would be less on the better type of soil than on the other. If it was so shown on the map, as near as I could determine it, I gave to the older priorities the type of soil that would take the least amount of water under a beneficial use.

At this place, Mr. Cochran, in answer to a question of the Special Master, stated that at the time of the rendition of the Oregon decree, the Court did not give any consideration to soil classification in determining priorities.

Continuing, the witness testified: We used the same system throughout. We used the same system in dividing the five classes of soil, Type 1, 1D, 2A, 2B and 3 in the A. L. Demaris land in the East Half of the Northwest Quarter of Section 21-5-36, between the four priorities of 1868, 1893, 1901 and 1908 in Proof No. 156, on page 112 of Exhibit 1.

You have called my attention to Proof 259 and 261, page 126, of Exhibit 1 (The Oregon Decree) under the name of H. R. Graham. The dates of priority are 1871, 1890, 1891, 1895 and 1904. The land is described as eighteen acres in the Southeast (quarter) of the Southeast (quarter) in Section 35-6-35 (which contains) soil types 2B and 3. You ask why I left 2B out of my tabulation (Exhibit 23). I think the location of the irri-

gated area of that particular piece of land is not in the 2B section of that forty-acre tract but is over to the side of it in (type) 3.

In tabulating the Southeast (quarter) of the Northeast (quarter) of Section 3-5-35, Proof 915, page 197 of Exhibit 1 under the name of H. E. Winn with the dates 1881, 1894 and 1896, I have tabulated the land as 2B and 3 leaving out 2A and 1R. I think you will find 2A is quite a ways from that land; it lays right in here, in 3 and 2B. In making that calculation, however, I have no knowledge of what water from any particular priority was used upon the 2B land. I classified it by putting the best land under the old right. The use of water up there as to the priorities is impossible to tell. I don't think there is any segregation up there at all; I can find none. The same is true with all the area so far as there is any place where more than one priority is used by a person upon more than one type of land. It is impossible to tell the priorities.

At this point the following may be noted:

THE SPECIAL MASTER: I assume, Mr. Cochran, that Mr. Cunningham's purpose in these exhibits—and I may be in error—was to take the priorities and then with the land classifications deduce the necessities under the priorities?

MR. CUNNINGHAM: Well, not quite that strong. If I may make the statement at this time, we have a soil map which attempts to designate certain types of soil and indicates them on the map.

Now, this witness took the decrees and permits and as best he could, applying what information he had—

THE WITNESS: Together with that map.

MR. CUNNINGHAM: —using his knowledge of the land and other data that was available he attempted to estimate the amount of irrigated lands in each classification according to the priorities set out in the decrees and the permits. We do not claim that it is accurate. We merely claim that it is an estimate that approaches possibly as near an accurate situation as the map is supposed to represent.

THE SPECIAL MASTER: Well, is it an analysis of the datum upon the map, or is it introduced for the purpose of controverting the datum upon the map?

MR. CUNNINGHAM: It is merely illustrative of the datum on the map.

MR. COCHRAN: In that regard, our cross-examination was designed merely to show and reflect the true picture of how that data was organized, and that it is impossible to make a real estimate.

MR. CUNNINGHAM: We will admit that.

THE SPECIAL MASTER: An examination of the exhibits will likely clear up the question in the court's mind anyway.

MR. CUNNINGHAM: While we are on this point, on yesterday I gave a statement to the court about the scope of the stipulation with respect to this Young's map, and I was in error at that time; if I may be permitted, I will read just the part of the stipulation covering this map.

(Reads from Stipulation No. 4)

MR. COCHRAN: We do not deny the section or the type of soil, but simply the present exhibit, and by reason

of the fact it is impossible to arrive at a correct acreage distribution according to priorities, we move to strike out the Exhibit 23, I think it is, which is the tabulation by priorities.

THE SPECIAL MASTER: The motion will be noted and ruled upon after examination.

MR. CUNNINGHAM: For the purpose of the record I should want it understood that any statement made by counsel for the State of Washington on yesterday or any stipulation in open court made on yesterday inconsistent with the written stipulation No. 4 shall be considered as modified or as withdrawn, so far as the written stipulation is concerned.

THE SPECIAL MASTER: It may be so considered.

MR. COCHRAN: That is satisfactory.

(51) MARVIN CHASE, recalled as witness for the State of Washington, testified: I am the witness who testified a moment ago. As a hydraulic engineer, I made an examination of the stream system of the Walla Walla River in Washington and Oregon, with the idea of giving some of the general physical characteristics of this stream, and the manner in which the water is used by the people of Oregon and of Washington. I reside at Wenatchee, Washington. I was a member of the Washington State Water Code Commission from the year 1911 to 1917 when our State Water Code was enacted. I was State Hydraulic Engineer of Washington from the year 1917 to 1924. I was also chairman of the Washington State Columbia Basin Survey Commission from the year 1919 to 1923. I am a member of the American Society of Civil Engineers and for more than fifty-one years have

been continuously engaged in hydraulic work in Nebraska, Colorado, Montana, Wyoming, Idaho, Washington, California and the Republic of Mexico.

The Walla Walla River is not different or distinguishable from the other mountain streams which we take water from. The water supply comes from snow in the winter months in the Blue mountains. The water shed is timbered and has a heavy growth of grass naturally. On the major portion of the stream, it has a gradient of from 60 to a 100 or 200 feet to the mile. It steepens as it goes toward the mountains. There are deposits of river wash along the course of the stream, made up of rock and silt washed from the stream. It forms small deltas along the way, the largest one is at the outlet of the canyon near Freewater. In a stream of this character where the gradient is steep, there are many channels used during high water which are more or less dry during the low water. If water is carried in these for any considerable distance, it is a very wasteful method of diverting water from a stream for irrigation. The use of water for irrigation is detrimental to the lower reaches of the stream. Along the major portion of the Walla Walla River, some water returns from the irrigated land to the stream but in no instance is there as large an amount as what is taken out of the stream, and in no instance does it return to the stream in the later months in time to be of benefit to the lower users on the stream. Excess diversion in the upper reaches, is a very decided loss to the supply of the stream. In the upper reaches of the Walla Walla River, there is fairly generally a wasteful use and a wasteful way of diverting the water. It is wasteful in the excessive amount which is diverted and placed on the land, in

the method of diversion, the long by-channels or by-passes made, in the lack of diversion or controlling works and of measuring devices, and in the over-diversion of the amount necessary, allowing the surplus to flow down unused sloughs or channels, oftentimes dry, without returning it to the stream. I am speaking now of the territory from the town of Milton, including both forks of the stream, up to its source so far as irrigation is practiced along the stream. There is both an over-diversion and a wasteful method of diversion along the stream. By over-diversion, I mean that there is an amount diverted in a ditch in excess of that which can be beneficially used on the land or of that which is set out in their permit or decree. In this reach of the stream above Milton, there are very few ditches that have at this time any diversion works, and in nearly every instance, they are of a temporary and of a make-shift character. When I speak of highwater channels for the diversion of water, I mean that there is a brush and rock barrier placed in the stream later in the season when they wish to divert their water, and the water is turned into an old channel for considerable distance and lower down some headgate, diversion work or control is put into their ditch. In nearly every instance an excess amount of water is turned from the river into the particular dry channel or slough, and the excess part where there is a regulation or control, is merely turned on down the slough or only in a very few instances is it returned directly to the stream. That method of diversion results in an excessive transportation loss in this dry or high-water channel and also depletes the stream system proper. It increases the weathered area of the stream to a great extent and therefore

adds to the transportation and evaporation loss. People want to use an excessive amount of water because it makes it unnecessary for them to perform as much labor in the diverting and controlling of their water and in the irrigating of their land. They make the excessive use of water do the service of the cost of labor and material. It would not be an excessive expense for these landowners up there to put in diversion works. They could use the material at hand, which consists of logs and rocks and put in diversion works as lasting as those that might be constructed in a more expensive way. The diversions in that part of the stream are mostly of individual landowners or the copartnership of a few. They are all comparatively small, I think, running probably up from only a part of a cubic foot per second of time to 14 or 15 c. f. s.

This delta formation along the river in the territory around Milton-Freewater, just below the canyon is hydraulically made from the rock and silt which has come down the stream. There is very little sand. There is no deposit of sand on the water shed; it is a basalt formation with heavy basalt clay or heavy loam clay on the surface of nearly all of the shed, and what soil comes down the stream is of a loam or clay nature. There are considerable amounts of rock and boulders in this formation and some local sand which has been manufactured on the way down.

As to the method of diversion in the Milton-Freewater country, I can describe the physical conditions surrounding the method used by the Milton ditch. The water each season is diverted into a channel, probably an old river channel; I think they probably put in their diversion works annually, because last year all the diversions

works they had there were of a temporary nature. And at this time they have a diversion there made of brush and rock and old pieces of automobile diverting the water from the main stream into this channel, carrying it down a distance of about three hundred feet, at which point there is an intake to a pipe line and a waste-way put across the channel allowing the excess water to flow down this channel for a distance of about four or five hundred feet, making a total distance of by-pass or channel of quite a thousand feet.

From that point it passes from the pipe line for one hundred or so feet long, and then it is constructed in an open earthen channel for a distance of probably a quarter of a mile, after which time it is returned to another former channel or slough, being picked up again down in the city of Milton, and at that point or about a mile from the point where it is diverted from the Walla Walla river there is a measuring device, but between the weir where the water is measured and the river there are a number of diversions taken off before the water is measured. There are no diversion works at the river at all. The channel about 300 feet long before the pipe line is used, which I spoke of, is part of an old river channel part of the thousand feet of channel which is used part as a head ditch or ditch bringing the water to their diversions and the balance of it is used to carry the water which is in excess of their diversion, back to the main stream.

There is an excess of water at the tail or outlet end of the Milton ditch so that another ditch company has its right based on the waste or excess water which they divert. There is practically 700 acres using so-called waste water in the Milton-Freewater territory. The

waste water, I should judge, is beneficially applied. I find the same general crops, the same character of orchards in the territory beyond the tail of the Milton ditch as grown on the rights from the river. The manner of use and type of diversion shown by the Milton ditch leads to a waste of water. It reduces the supply of the main stream particularly in the hot months of the summer when the larger amount of water is required for irrigation purposes, consumptive use. It is an injury to the stream system below the Oregon line.

I recall the ditch known as the Zell ditch. It is my recollection that there is an artificial ditch where the water that is spilled over from the controlling works of that diversion is returned to the stream.

In speaking of controlling works, I do not include divisional weirs. Controlling works would necessarily have to have a measuring device to enable the regulatory authorities or the water master to rightfully apportion the water of the stream to the various users.

On cross-examination, Mr. Chase testified in part:

The territory irrigated above the town of Milton is narrow in places; other places it is fairly wide, probably not over three-quarters of a mile wide at the widest point. It is irrigated in narrow strips along the creek above the forks on either side but there are some fairly good fields. I would say it was different from a narrow canyon.

The soil formation up that canyon is of the cobblestone or boulder type with fine silt filled in with small rock which is broken off the hills or has come on down the stream, mostly of an angular shape type. The general thickness of the soil on top of this gravel or boulder

formation varies. Some places on bars it lays very thin, other places it is quite deep, going down to a depth of eight or ten feet or maybe deeper. I haven't dug any test pits, but going along the stream, the stream has cut into a good many banks where it shows fairly solid soil down to that depth. How much soil there is in those bars where the rock shows up more plainly on top I don't know. The soil, you will find, probably would run down in that to some depth.

The character of the stream, a grade from 60 to 200 feet to the mile, renders the stream very swift. I do not know what the grade is above Milton to the forks, except to estimate it over the whole distance. I do not think it is an average of 90 feet to the mile. Without looking at the hydrographic data, I wouldn't be able to state what the maximum flow of the river is. I have been more concerned with the minimum flow than I have with the maximum. I have observed that the current is so swift that the stream changes its position. It isn't different than most streams of that gradient. Trees and other debris changes it in places and other times it comes back to old places. It is just a changing channel.

Assuming a gradient of 80 feet to the mile and with a current of 1200 second-feet of water coming down, the ordinary log and brush dam that the farmer will put in, will hold that current if properly constructed. It would not cause the river to wash out a channel at a different place, if properly constructed. A dam to hold that kind of current on that kind of grade would not require a cement foundation. There are two methods on streams of that type. You can construct a low dam entirely across the stream, of log cribs and rock, with

the proper abutments to it, allow the whole stream to go across it, or you can construct a lower dam and use a type of flash-boards on it, which you can take off during the high water period. Either type will be very lasting. Most of those farmers up the stream, who dig out individual ditches, irrigate fairly small acreages but I think they would have the financial ability to construct a low dam to hold the current and power that that river assumes. If I were a farmer there that is what I would do. I have observed that the concrete dam and diversion works made from the Tum-a-lum into the Little Walla Walla was partly torn off by the force of the stream there. I think the one down at the Hudson Bay is as solid across the stream as when it was built.

Those old channels (used) in the diversion of water up the stream have a cobblestone or boulder formation and in a measure a few of them have rather silted up with some soil and for others they make a new place every year. If the water comes in too close to their former diversion and takes it out, they dam the water up again against the gravel bank.

I believe that the proper method would be for them to take out ditches in place of using the old channel or if they took the (water) down a channel a ways to their headgate, at that point (they) should return the undiverted water to the stream. The old channel at the head of most of those ditches is washed every year. A ditch would have the same propensity. In any instance it will be necessary for them to dam up the stream some or else go quite a distance above to get a gradient to bring the water into their ditch. With a fall of 80 feet to

the mile, there wouldn't be so much distance to go, (yet) it is evidently true that it is a greater distance than the farmer wants to go, from the fact that he puts in a crib in many instances out into the stream, and, of course, which the high water takes out, just a temporary crib made up of willows and brush and rock and other things in a temporary way. In fact, all of them along the stream appeared to be, even as large as the larger ones, as a very temporary way of diversion of water from the stream. There would not be an annual expense in a ditch from the dry channel to the original channel. If they had the same ditch, the same one back to the stream would be there for all time. If the stream changed its position by reason of a torrent in high water time, to wash out their canal or ditch down to the point where the water was returned to the stream, then, of course, there would be expense, but in very few instances, if any, does (the high water) reach down their ditch.

I [illegible]nly made an intensive study of this stream for the past 2 years and this far in 1934, although it is a condition that we have to study and have studied for all time along all streams. I did not make any study of the return flow to the stream up there. I don't know exactly what you mean by return flow. How do you distinguish between the unused part of the water which has been diverted from the river, put onto the land, and returned to the stream, and the water that naturally gathers along the stream. In other words, the stream channel gathers the water from the watershed, and it gathers all the way down so far as there is any water to gather from the sides. Instead of return flow it is

the water that is being gathered. It is not possible in the study of the stream flow to distinguish between the water that is naturally gathered by the stream and such water as may be returned to the stream from irrigation. The only way in which I could answer that question is to give you my experience on streams which, because of the excess use along these streams for years and the denuding of the watershed along the streams and the farming of the land, it has resulted in the lower rights on the streams, with streams of about the gradients the Walla Walla River has, of being short of water or the rights destroyed entirely, and on those streams that I know of or had experience on that so-called excessive use of water along the stream has not been beneficial, in fact has been detrimental to the orderly way in which the water comes down the stream, and especially during the drier months that the water is used for irrigation. In my study of that stream above Milton, I do not know whether or not any of the water diverted comes back into the stream. I cannot differentiate between the natural water that is gathered and that which is put onto the land. When I say that the excess water is wasted, I know it has been wasted to the extent to which it has increased the wetted area and (of) the exposure to evaporation and other consumptive losses. I did not make any study to determine what the loss would be from evaporation and excess seepage.

I haven't examined the diversion works in Washington lately. At the time I examined them, the diversion works upon Mill Creek and Yellowhawk were different from the very few diversion works along the Walla Walla River above Milton. Some of them (upon

Mill Creek and Yellowhawk) were concrete; some were of one type and some another; they all have controlling works or measuring devices. I know at this time of no measuring devices along the Walla Walla River above Milton.

In the part of the stream above Milton, I would judge the drainage ordinarily is to the river. The drainage is not entirely to the river on the surface; sometimes the land lies back the other way, just as it has been formed by the stream at other times. I have not examined the Tum-a-lum. I am not qualified to answer the question whether during the time I have known the stream from 1917 to the present time, during the hot months of the year, July and August, there has never been any water come down the full length of the Tum-a-lum. I have seen it dry.

The lands alongside the stream bed itself are in trees or brush at this time, or being farmed and have a great deal of very fine soil and some clay soil in it. In no instance is it sandy soil. The channel of the stream from Milton to the fork is all covered with rocks, owing to the velocity of the stream it leaves no soil in sight. That same condition of the river channel exists below Milton to the state line almost.

Since I first knew the stream there has been development along the river. There has been no installation of measuring devices and diversion boxes on the Walla Walla River itself except the diversion work down at the head of the Hudson Bay and the one now building (for the Little Walla Walla).

From my investigation I did not learn when the Finis ditch was built. In reading the decree and the other papers in connection with it, it is my recollection, that the suit was started about 1906 before the enactment of the Oregon Water Code and the determination of it was about 1912 when the decree was entered.

W. I GERMAN, for the State of Washington, testified in part (58-65):

I live on a farm near the Pepper's Crossing bridge, south and west of town. The Walla Walla River runs through it. The Oregon-Washington state line is its south boundary. It is about 1½ miles east up the river from the Milton-Walla Walla state highway. I have lived in Walla Walla County 26 years, most of the time in the Walla Walla River valley. In October, 1924, I moved to the Duran place about a half mile farther down the river and lived there until the fall of 1930 when I moved to my present place and have lived there since. We raised alfalfa, wheat, pasture and had some dairy business, on the Duran place. We raised wheat on the land opposite the river from where the buildings were. We crossed the river back and forth with teams and equipment to farm the part across the river. There was a pretty good supply of water in the river during July and August the first year I occupied this place, as I remember it. The stream banks of the river where we forded were 60 to 70 feet wide I should judge. The stream of running water was probably 20 feet wide, and a foot and a half deep in the middle of the stream in July and August. There was not very much difference in the supply between the (two) months. Since 1925

the supply of the stream has been gradually lessening in amount during the summer months. The supply of the stream opposite the place where I now live goes very low during the summer. It would be hard to estimate the drop in it but it is very much different during the summer months from what it was in 1930. I would say that the supply of this stream in that vicinity during the time I have been acquainted with it has generally been growing smaller.

The year 1931 was an extremely dry year all over. In '31 I was farming a piece of land further up the river and the spring up there that had not been dry for 40 years, went dry that year. I had greatest loss on account of the shortage of water in 1929. (It) was a very dry year, too. I suppose 1925 was an extraordinarily wet season. I found '29, '30 and '31 three very dry years. I know during '29 and '30 we didn't get much water. I have not been irrigating since 1930. I did not particularly pay any attention to irrigation conditions during '31, '32 and '33 only as I would cross back and forth across the river. I had no knowledge of what the diversions by my neighbors above me were at all. As I remember it, the rainfall wasn't as good in 1933 as it had been some years, other years. The river was extremely low all summer, that is, for the level that we usually expect there, but whether it further up was diverted or not, I couldn't say just why that was. I made no measurements at any time. As I say, it was more—my observation was more from crossing back and forth, it was either high or it was low, or extremely low. I made no bench marks of the place where the water stood at pre-

vious years, I just took it from my recollection. During the past few years in my neghborhood, the irrigated land has not been increased. I did not increase it upon my land.

J. C. HAMMER, for the State of Washington, testified in part (67-78):

I live on 17.69 acres bordered on the south by the Washington-Oregon state line and situated in Washington about a quarter of a mile west of the Milton-Walla Walla state highway. The East Little Walla Walla runs through my place. It has a water right from the East Little Walla Walla River with a priority of 1891. I purchased and took possession of this property in January, 1919, and I have lived on the place ever since. The East Little Walla Walla River as it passes through my property is about 14 feet wide between banks. There was an abundant supply of water there when I took the place. In 1919, during July and August, I would judge, in the middle of the stream (the water) was about 12 inches deep, something like that. In the past few years during the summer months it has been diminishing. It became noticeable along about 1921. There has been a very pronounced deficiency of water in the past 6 years; '21 was when it started to diminish, then possibly about 4 years ago it diminished very fast. During the last 2 or 3 years during the summer months (there has been) very little water there. I raise prunes, apples and alfalfa hay. During the first 3 or 4 years I was on the place, it was practically all in fruit, prunes and apples. I have removed 350 prune trees and throwed that into alfalfa, the trees in the lower part, where it is gravelly, where I couldn't get water for the lack of water, I pulled them

out; they died. Lack of water has been the chief cause for changing to the form of crop I now raise. I have had to change the character of my farming from fruit raising to mixed farming and raising more stock. I couldn't get the water to that end of my place to save my life; I didn't have enough of it. The water supply is sufficient up to July 1st; then is when it begins to diminish and goes down, and after that I get very little. I had oceans of water in 1919; we had plenty of water in the year 1920, too; then in 1921 it began to diminish. The water master went upon my branch to distribute water in 1931 or '32. I pulled out the trees 6 or 8 years ago. I cut the trees down on the gravelly land as they died. They began dying along about 1922. They did not die from disease. I didn't examine them for wood borer. I knew what was wrong with them. I set them out in 1921. When I took over the place, this gravelly spot was just bare ground. There had been alfalfa in it before, but that was run out.

The Hoffman ditch diverts no water from the East Little Walla Walla. It is from the Spring Branch. The Ross-Chapman ditch comes out just below the state line on the north side of the road. I wouldn't think it would take all the flow because it don't get down there; there is a dam on the Oregon side which is the last dam in Oregon; they dam it off with sacks; what goes through we get, what don't go through, we don't get. I have no knowledge as to whether that Ross-Chapman ditch is ahead of my land or not. I haven't ever investigated to find out whether the man immediately above me has a prior right.

During July and August, 1932, the East Little Walla Walla had a small flow of water across the state line. My well, they tell me, is 18 feet deep. But you dig down at the edge of the ditch four feet and your soil would be perfectly dry. (My well) is a drove well; I couldn't tell you how far it is to the water level there. The underground water rises on my land only in one place, where there is a gully and that is only during the fore part of the season and that don't occur every year. During the time that my trees went dry, we got a stream about 4 inches deep and about 12 inches wide upon the place. I divert the water into a flume immediately and then take it across a gully. The grade of the flume is about a quarter of an inch to the rod. It is almost on a level.

CARL ROSS, for the State of Washington, testified in part (82-91):

I live on property that at one time belonged to my father's and mother's estate. The East Little Walla Walla goes through the place but I am on the back side —my share of it is back just off the creek. The place is located about a half mile west of the Milton-Walla Walla state highway and about a half mile north of the state line. I have lived there practically all my life to date. My brother and two sisters have occupied this place and for a number of years (it) was farmed as one place. Later (it) was divided among the children.

The Big Spring Branch joins the East Little Walla Walla on the place that belonged to this estate, about 200 yards above the buildings of the old homestead. It now belongs to my brother, Royal Ross. The elevation

of the surrounding land where the buildings of the homestead are is about 2½ feet above the stream. We used to have a small power plant located at the back of the home on the banks of the East Little Walla Walla for lights and for power. We generated electricity there by means of a water wheel. The water was diverted out of the Big Spring Branch about 300 yards above by means of a flume down to the water wheel. I couldn't say exactly when we built the power plant. It must have been about 25 years ago. It has been many years ago anyway. We run it at night and in the day time when we needed the power, used it for washing machines, churns, electric lights and so on. We continued to operate the plant up till '26 or '27. A long time ago we had lots of water, then it got so we didn't have enough, couldn't run the plant at all. In the summer time it just completely stopped. We first noticed the amount of water decreasing round '24 or '25. Where we used to have all the lights we wanted, it got down to where we had only one or two lights. I couldn't say exactly when we discontinued the plant. It must have been in '26. There used to be lots of water run in the Big Spring Branch all summer long until the last few years. We noticed the decrease in the summer flow around '25. It went down some before that in '21, '22, '23, along in there but not much. The last few years the East Little Walla Walla above the place where the Big Spring Branch joins it, went dry. That condition has existed about 4 or 5 years. There used to be a good stream running through there. We used to fish in it and go swimming in it, had a little boat I ran on it from our old homestead up the creek about half a mile. The supply has (gone) down the last

6 or 7 years. It goes steady when it goes, but then all at once it just drops, you ain't got anything. It is just completely dry down there now. I had fruit on the part of the place I own but I pulled it all out. I pulled the last out in 1930. I haven't been able to irrigate my place during the last 3 or 4 years—haven't got no water at all. I quit it. There's no water in the ditch in the summer time. I haven't even got stock water. I have been raising some corn and some potatoes—I started some alfalfa. My brother, my sisters and I have changed the farming there in the last 5 or 6 years from orchard to others. Pulled out the orchards and been raising corn and potatoes, and some stock. Some of this change has been through lack of water and some of it is because the fruit wasn't paying. We used to irrigate and we had the water to irrigate with. Six or seven years ago was the last time I irrigated any part of the place. It was about the same with my brother's place, I guess. I have pretty heavy soil. It is adapted to fruit raising if I had the water.

I have been acquainted with the main stream over by the McCoy Bridge and below. I was over there very often during my early days. I used to go swimming there. I had friends over in that part of the country I used to visit. Mr. Heidenrich, a blacksmith, used to shoe our horses for a number of years. I had occasion to observe the general supply of water in that river as I crossed. Fifteen or twenty years ago there was quite a bit of water came down there; that is, not as much as it does run in the spring, but there was a good stream of water run there all summer, that is down below there, but now it goes clear dry, along in by the McCoy Bridge.

I never (swam) up that far. We had big swimming holes down closer to us there. The water was about 15 feet deep. You can't hardly find a swimming hole now big enough to go swimming in. They filled up with gravel. Several cloudbursts up the main stream brought down a great deal of sediment and those swimming holes filled up with that sediment to a certain extent. I am not very well acquainted with the stream above the McCoy Bridge.

There are no springs on my place. I think we could get water in about 7 or 8 feet, if we dug a well. There is no gravel in my soil. Over in the river bed there it is mostly all gravel. My place is not generally considered underlaid with gravel. It is a very deep soil. I have an 1892 water right for 5 acres and an 1891 right for 10 acres from the (East Little Wall Walla). We get our (water) right on the state line. Ours is the first diversion after the water crosses the line. The Water Master started measuring the water 3 or 4 years ago. He has been distributing to me what there was to distribute since that time. I get my water from the Ross-Chapman ditch out of the East Little Walla Walla (called in Washington Exhibit 11, East Spring Branch). I don't take any water out of the Big Spring Branch for irrigation. The only water that we used from the Big Spring Branch was for the power plant when the place was all together. The place was divided up three years ago, I believe.

It was about 3 feet across the water wheel. It was an undershot. Then we took that out and put in a turbine about 1912 or '13. I don't know what size it was. I don't remember the size of the generator and how much power it took. We used the generator over twenty years. At

one time we could use 15 or 20 lights. We had about 3 or 3½ foot fall. Beginning about 1925 the water supply went down—it was rather a sudden change — so we couldn't use (the power plant) any more.

ROYAL ROSS, for the State of Washington, testified in part (100-106, 422):

I live near the place described by my brother, Carl Ross, a moment ago. I have lived on my parents' place, now my place, for 41 years. There wasn't much change in the supply of water in the Big Spring Branch until about 7 or 8 years ago, when we commenced to notice a change in the creek, going down some. We noticed a change in the amount of water that was available for the power plant more than anything else, I suppose on account of the lights. From 1920 to '26 or '27 is when we noticed the worst change in our light plant. There was a gradual change from year to year. I would say about '21 or '22 there was the most change of any time, and then it gradually got worse each year until the last 2 years we had the plant, we had very little light or none at all scarcely, maybe one light or two lights. I don't recall the year we put the plant in. I believe it was about 1905. We ran it until '27 or '28.

The change in the supply of water in the East Little Walla Walla above where the Big Spring Branch joins it has been more noticeable in that creek that it has in the Big Spring Branch. In the last 9 or 10 years, it started out with a small change, kept going down each year; I would say along about 6 or 7 years ago there was an awful large change in the creek—went down over night, it seemed like, when the dry season came on—over night

it went down like it had been taken out above, you know, and dropped maybe 6 inches over night; the rest of the season it would be very low. The last 2 or 3 years there has been scarcely any running water in it at all. There wasn't any water in it last year; it was practically dry.

I went over to the main stream by the McCoy Bridge occasionally. I occasionally went over there to the blacksmith's place. I have been across the stream a number of times in recent years. There used to be plenty of water 15 or 20 years ago but in the last several years, crossing there in the summer months, I noticed the stream bed was dry. I never swam that far up; usually swam down further. I couldn't say whether this change in supply has been gradual. I never observed it enough to know just how it went down from year to year. But I would say the supply in recent years has been much less during the summer.

I own about 35 acres. I get my water from both creeks, the Big Spring Branch and the East Little Walla Walla. The Ross-Chapman ditch comes out of the East Little Walla Walla at the state line for 15 (16 see Wash. Ex. 11) acres. The other ditch (Eiffert ditch) comes out of the Big Spring Branch about a half mile up in Oregon, for 13 acres. Eiffert is on two ditches. (Mine) is the west one. I get practically no water from the Ross-Chapman ditch. I don't irrigate from the Eiffert ditch. I have had plenty of stock water—that is all I use it (Eiffert ditch) for, practically, for pasture land.

I raise a little hay, alfalfa, prunes, apples, blackberries, some vegetables. I have 16 or 17 acres in fruit. I have changed the character of my farming some in the

last 10 or 15 years. I took out some trees, not a great many, and went into smaller stuff, stuff that don't require much water, such as rhubarb, deep-rooted vegetables. I don't raise any more stock than I used to.

My place needs irrigation but there is no use to try to irrigate it without any water. I make no attempt to water it because I have no water at the time of year I need it. I have plenty of water in the Big Spring Branch but it is for the pasture land—it is salt grass, some blue-grass; wherever the water has touched it there is blue-grass. The water table used to be so close to the top that irrigation used to make the alkali come out but there is a tile put along the road—the road goes along the edge of it. If I had plenty of water, I could wash it out now. The road along the center line of the SW¼ of Section 11-6-35 is the highway running along the edge of my place between Milton and Walla Walla. It runs between my land. The highway has been tiled along the edges 2 or 3 times. The smaller tile was put in about 15 years ago. They put in the larger tile when they put the concrete on, about 1920. The tile didn't exactly drain my land; I figured it kept the alkali from coming up. I figured the alkali wouldn't come above a certain level of the tile.

That salt grass condition does not exist on my brother's place.

Ivor Williams, for the State of Washington, testified in part (110-113):

I live on the Enzroth place of 110 acres now owned by Mrs. Nora Williams, my mother-in-law. It is located along the Walla Walla River in Washington, gets its water from the Yellowhawk, and has a priority of 1895.

I irrigate the place when I have water. I raise alfalfa mostly, a little barley, some pasture, like sweet clover, bluegrass. I began operating the place in '28 and have been operating it since. It was in winter wheat in the spring of '28, when I moved there. The next year we had in some corn and about 20 acres of late potatoes. We haven't been able to raise crops of that kind since. We didn't have the water. It is shut off. We have had to change the character of our farming and raise alfalfa and barley hay. When our water gets short, the Water Master comes around and takes the water away from us and gives it to people that have got a prior right to us. They have always had that prior right. I would say that the soil was a medium loam to a heavy—down by the river I would call it a heavy. It is adapted to raising potatoes and corn and garden stuff—almost anything provided you have the water. I am not able to raise any of those crops at the present time because of lack of water—you take a chance.

The Water Master first came on distributing water in '29, the first year of the adjudication. In '28 we had all the water we wanted — we took all the water we wanted. But in '29 the Water Master in regulating the distribution of water closed our place off. In 1929, he closed it off about the middle of June. Between the years 1929 and 1933, it was between the middle of May to about the first of July that he shut off the water. In 1930, I can't say offhand. In 1931 and '32, it was about the first of June, somewhere around there. In 1933, I think it was about the first of July—we had more water last year on the Yellowhawk.

HARLOW BARNEY, for the State of Washington (116-145, 300-308).

At this place, the following qualifications of the witness were agreed upon in open court:

Harlow Barney resides in Walla Walla County, Washington. He is Water Master of the district including the streams of Walla Walla County. He is appointed by the Supervisor of Hydraulics of the State of Washington under the provisions of the State Water Code. He has held this position since and including the season of 1926. As a part of his duties as Water Master he regulates and has supervision over the administration of the diversion of the water from the Walla Walla River and its tributaries in Walla Walla County.

The witness then testified in part:

J. C. Hammer gets his water from the East Little Walla Walla partially out of the Ross-Chapman ditch and part out of the small diversion we call the Hammer flume at the state line, right at the Interurban Traction bridge, on the East Little Walla Walla. There are two priorities in the Ross-Chapman ditch, a '91 priority and a '92 priority. Mr. Hammer's priority is 1891. When Mr. Hammer is irrigating on the right bank, he diverts water through a small flume for that tract, and then when he irrigates on the west bank sometimes he closes the flume and takes it through the Ross-Chapman ditch.

At this place counsel for the State of Washington stated: For the purposes of the record, I will state that the Ross-Chapman ditch appears on the official map, Washington's Exhibit 17, as taking from the East Little Walla Walla River at a point near the state line in the

Northwest of Northwest of Fractional Section 14, Township 6 North, Range 35, and runs westerly parallel with the state line, and then in a northerly direction in the Northeast of the Northeast of Fractional Section 15, same township and range.

The witness then resumed: The Hoffman ditch is diverted out of the Little Walla Walla Spring Branch.

At this point counsel for the State of Washington explained: The Hoffman ditch was mentioned (by mistake). It really has no part in this examination. I wanted to locate it since it was mentioned. The Interstate measuring point for this ditch is designated on Washington's Exhibit 17 as Number 6.

The witness resumed: The point of diversion for the Hoffman ditch is located about a quarter of a mile south of the state line in Oregon in Section 14-6-35. There is one Oregon and four Washington users on this ditch. It flows in a northerly direction.

Carl Ross gets his water out of the Ross-Chapman ditch and no other. Royal Ross gets his water from the Ross-Chapman ditch and the Eiffert ditch. The diversion of the Eiffert ditch is out of the Big Spring Branch in Oregon. The Eiffert-Dyer ditch is just east of the Eiffert ditch. The measuring point of the Eiffert ditch is designated on Washington's Exhibit 17 as 4-A and of the Big Spring Branch, as 5. Royal Ross does not irrigate to any great extent from the Big Spring Branch. It is largely stock water. The Big Spring Branch is designated as Spring Branch, and the East Little Walla Walla, as East Spring Branch in Washington's Exhibit 11.

Neither Doan Creek nor Stone Creek contribute any water to the main stream during the low water.

I first began regulating the Walla Walla River and its tributaries in 1929, the first season after the decree had been entered adjudicating the rights of the Walla Walla River and its tributaries. Prior to the time of the decree, Washington Exhibit 11, we tried to make peace among the water users and coax them along. I had no real authority to shut off the water until the relative rights had been determined. We regulate the stream on priority under this decree. When there is sufficient water in the stream in a given tributary to satisfy the right of a certain priority, we allow that to run if there are no prior rights on the stream below that tributary, and as the water supply diminishes we cut off the rights of the later priority to satisfy the rights of the earlier priority in accordance with the stream supply. This method is in force generally over the stream system.

The time of stream shortage varies. We generally start to regulating the stream in May. In some years it may be as late as June. Prior to the time we start regulations, we allow the water users to use such water as is available as long as all the rights are satisfied. It is only when a shortage begins in a given stream that we begin our regulation to the awarded amounts. We make a regulation and put a notice on the diverter's headgate. (The time) it takes to cover the stream system in this county varies; it depends on the number of rights you have to curtail; if we are curtailing the priorities (it requires) from 3 to 8 days to make a regulation.

I have kept a list of the regulations that I have made of the stream system from the time I began regulating

the stream under the decree. I made a tabulation of those regulations for each of the years beginning with the year 1929 until last season. This tabulation is taken from my original records. I have checked it with the original records and to the best of my knowledge it is correct.

At this place, the tabulation, being a tabulation of the administration of the related stream system in Washington for the years 1929, '30, '31, '32 and '33 by Mr. (Harlow) Barney, Water Master, was introduced in evidence as Washington Exhibit 27.

The witness resumed: I started to make closures of all rights subsequent to 1892 from June 1st to 10th in the year 1929. I may have had the stream under regulation down to the awarded amounts before this. Then from June 11th to 18th, all rights subsequent to '92 were closed on Mill Creek below Gose Street. Lower Mill Creek generally has a return water that supplies those lower rights a longer period of time than the upper stream rights. It varies from year to year. We regulate Mill Creek with relation to Garrison and Yellowhawk Creeks according to priorities of each of these streams and on Mill Creek above Gose Street. We do not take into account the priorities below Gose Street when it comes time for a closure of those rights (on Lower Mill Creek) because the water all sinks in Mill Creek near Gose Street.

I began closing in 1930, June 10th to 19th and from June 25th to July 6th, on Mill Creek below Gose Street. In 1931 I began regulation May 26th to May 30th, closing rights subsequent to 1894 on Upper Mill Creek, Garrison Creek and Yellowhawk. On Mill Creek above Gose

Street, I closed the rights May 30th to June 3rd and on Mill Creek below Gose Street I closed the rights from June 3rd to 7th.

There has been very little change in the last few years in the summer supply in the tributaries of the main Walla Walla River to the west. I refer to Mud Creek, East Mud in Oregon and Pine Creek. There has been a noticeable increase in the amount of water in the lower reaches of those streams. I live on Lower Mud Creek. I have lived there practically all my life. The supply of the water of lower Mud Creek has increased considerably during the low water season in the summer, as well as in the spring months, too, since I was a young man in that locality. There has been an increase of irrigated land in lower Mud Creek since 1917. Lower Mud Creek enters the Walla Walla River about a mile or less north of the SW¼ of Section 31-7-34 approximately 2 miles above the town of Touchet. Pine Creek enters the Walla Walla River in a southeasterly direction from the Town of Touchet and nearer Touchet than Mud Creek. One of the tributaries of Pine Creek up near the state line is the Little Mud, called South Mud in Oregon. The summer supply of Pine Creek has increased in recent years. There is about 800 acres irrigated at this time on Little Mud (and) Pine Creek. During the time I have regulated the stream under the decree, I have never closed any of the rights on Little Mud or Pine Creek during the summer. There has been sufficient water to take care of all the rights.

In the East Little Walla Walla, up near where the Rosses live, a very sudden drop generally occurs sometimes in May, sometimes in June and once I believe it

happened in July. There has been a change in the summer supply. The year 1926-1927 there was a fairly good amount of water came across the state line to those users under the Troyer ditch and the Ross-Chapman ditch but in '29 the Ross-Chapman ditch used up all the available water and didn't have enough water to take care of their '91 awarded rights. Since '29, it has been short. They haven't had enough water to take care of their rights during July and August. The Troyer and the Cauvel ditch irrigate small acreages. The Troyer ditch is on the right bank and the Cauvel on the left; they both take out from the same diversion dam in the East Little Walla Walla. The summer supply of the Big Spring Branch during the last 6 or 8 years, has diminished to some extent. There has been a tendency for the supply of water in the streams and tributaries to the east to be less during the summer while those to the west down in the Pine Creek (region) have had a greater supply.

In April, 1930, we had a sudden drop in the river and we were threatened to have to close off all the inferior rights, and it seemed awfully early in the season, so I made an investigation of the water supply in Oregon to see where the water had gone. When I went up over the main stream, I found out that the water was all being diverted into the Little Walla Walla River and the Hudson Bay ditch. The division of the Little Walla Walla in Oregon is right in the City of Milton at what we call the broken-down headgate, where the headgate was washed. I got the Water Master of Umatilla County, Mr. Spencer, and requested him to turn down some of the water and he answered that he had no authority to deliver Washington any water. At that time, in 1930, we

would have practically all the ditches running on the lower reach(es) of the stream (in Washington) and they had been running possibly a month. In speaking of the supply in the Big Spring Branch and the East Little Walla Walla, I am speaking of the streams that rise up in Oregon and flow down across the state line, and that is also true to the west in connection with Pine Creek and Mud Creek.

I was appointed Water Master in the summer of 1926. Before the (Walla Walla River) decree was signed I cut off those rights only that were under State Engineer's permit and I took charge of Stone Creek and Doan Creek in place of the former Water Master. Prior to 1926, I had fished the East Little Walla Walla, Big Spring (branch) and the main branch above. My knowledge of these streams was casual. I did not observe the condition of the water so as to make comparisons relative to the flow, only when I would wade it when we were fishing. I made no measurements prior to 1926. My first experience in the regulating of water was in 1926. I had never had any experience in the distribution of water only as a water user.

In the administration of the decree, Washington Exhibit 11, we found that there was a dividing point in Mill Creek at Gose Street, during the low water period, that we would use in the distribution of water. I never examined the stream bed thoroughly but we had the court decree and we had to go on the face of the record and when the water becomes to a certain flow, it automatically takes care of itself by virtue of priorities up stream. For instance, Yellowhawk has the larger priorities under acreage and consequently the stream diminishes Mill

Creek flow at Gose Street earlier than we would have occasion to examine this stream bed. In the ordinary flow it goes dry there for about a quarter of a mile but it starts rising again. The springs in the steam and small tributaries cause it to rise sufficiently to supply the lower users on Mill Creek. In the distribution of water we recognize that particular feature of physical conditions that arises each year. In 1929, we closed the rights subsequent to 1892 (on Mill Creek) below Gose Street between July 11th and 18th; in 1930, between June 25th and July 6th; in 1931, between June 3rd and June 7th. The earlier day (in 1930 and again in 1931) was caused by reason of the diminution of the water supply. The available supply of water in Mill Creek is what regulates the closing of these rights at various times. The drop in the water in Mill Creek each year comes very rapidly.

The drainage basin of Mill Creek is right adjoining the drainage basin of the Walla Walla River in the Blue Mountains. The Walla Walla watershed has a larger area. I don't believe from my observation of the stream that the Walla Walla River supply falls as remarkably quick or as sharp as in Mill Creek. As to whether we had a short year on Mill Creek in 1930, we possibly might have closed rights off on Mill Creek in Washington because the Oregon diverters had taken the water that formerly came across the state line for lower river users. We found after making our investigation in 1930, that it was the practice of the farmers (in Oregon) to go up with scrapers and divert all they could get. My parents live on the Little Walla Walla. I visted home a number of times. I have been there on numerous occasions when they have been doing the work on the Little Walla Walla,

and I have been there with my stepfather, who diverts the water into the McIntyre ditch, and it was always his policy to go and take all the water he wanted. It was always the policy of the irrigators to go to the Little Walla Walla and get their scrapers and teams and sacks and sack that off and then go on down to the Hudson Bay. Back as far as I have been acquainted with it, since 1920, each year the farmers have turned water into the Little Walla Walla.

The dates of my closing off the water in Mill Creek don't necessarily indicate what the water supply in Mill Creek was. Some times it does; in 1929 it (did); in 1930, the whole supply was picked up over in Oregon. We had to go and satisfy our prior rights first in Washington by closing off inferior rights on the related stream system. There is no diversion from Mill Creek for Oregon lands.

I spoke of regulating the tributaries of the Walla Walla River. I regulate the main stream in its relation to the tributaries also. There is a decree which requires us to regulate Mill Creek (with a division) at Gose Street.

(300) Prior to the first regulation of the stream in 1929, it was the custom to divide the waters of Mill Creek and Yellowhawk Creek on a percentage basis. Mill Creek got 60% and Yellowhawk 40%, during the low water period. As between Yellowhawk and Garrison, during that same period, Yellowhawk got 60% and Garrison Creek 40%. It was the custom that had been handed down. The decree modified this custom so far as the division of water up there is concerned, and respected priorities. I administered the division of the water at that point by allowing the water to go down Mill Creek to

satisfy priorities on Mill Creek down to Gose Street in their relation to the priorities in Yellowhawk and Garrison Creek and the rights on the lower stream, the main stream. During the time that I was Water Master prior to the first regulation of the stream in 1929, Yellowhawk or Garrison contributed no water of any amount to the main stream during the low water period, and the (water) in McEvoy Spring Branch was practically all used in that branch.

I do not know how long the custom of division of sixty-forty existed prior to the time I went on as Water Master. It was the contention of the irrigators that that should be the division when I went on. When the decree came in, we administered the stream, Mill Creek, Yellowhawk and Garrison Creek on priority, along with the priorities on the Walla Walla River. Prior to the decree on Yellowhawk and Garrison Creek, there were priorities, after I made the division (between these two streams). The farmers or the irrigators took the water as they could get it. They had a water master, but we had no authority without a decree, because we could not determine the relative priorities. After the decree and the new division, the waters were administered to the individual farmer on priorities. There was no custom of division on Titus Creek. They would take whatever they felt was necessary. After the decree was entered there was water went down Cold Creek to satisfy rights on the stream and the main stream. Prior to the entry of the decree, there was not. This division up at Mill Creek in no way affected lower Mill Creek only in the way of return water, the seepage or something like that. Prior to the decree Mill Creek water flowed past Gose Street,

with the exceptions of the very low water years. Since then when the low water comes, they consume that water. Prior to 1929, I never cut off any of the rights above the Gardena intake for the purpose of supplying Gardena with any water.

Prior to the regulation of the stream in 1929, a larger percentage of water went down Mill Creek. That affected the amount of water that came down Mill Creek and into lower Mill Creek either through seepage or across the surface. The amount of water in lower Mill Creek has been less, at least part of the year, since the regulation of the stream on the decree. Many of the rights on Yellowhawk Creek and particularly this right on Titus Creek, have received less water during the summer season since regulation has been put into practice on Mill Creek and by the same token other users have received more. One of the principal reasons why (some) have received less water is that it is turned down to supply the Gardena priority and other priorities on the stream.

Fred Dill, for the State of Washington, testified in part (161-167):

I live on the Anna Jones property on Garrison Creek located east of Alder Street, Walla Walla, on the north side. Its water right from this creek has a priority of 1900. There are 5 acres in the tract. The stream runs through it. When I took possession in 1925, it was in cherries, peaches, apple trees and prunes. I had sufficient water to irrigate my land in summer until 1929 when the water master began regulating my rights. He shuts the water off from my land always abo[illegible] the first part of June. As a result of lack of water I lost the 2 acres of prunes entirely and they are just laying idle. I am just 3

blocks from the city limits and I got city water to keep the trees alive but it is too expensive. Garrison Creek runs into the Walla Walla River from the north. It runs out of the Yellowhawk and the Yellowhawk runs out of Mill Creek. When I first went out there in 1925 the water run up as late as July—in July we got some. The neighbors among themselves run that water. We had quite a bit of water that time. If there was water there I took it and if there wasn't I didn't. I had no measuring box. From 1929 on I had. At that time I got water for a longer period in the summer than I do now when the water master is on.

LAWRENCE E. CUNDIFF, for the State of Washington, testified in part (169-175):

I own 20 acres of land on Lower Cold Creek. It is a spring creek, totally in the State of Washington, a few miles below the City of Walla Walla, comes from springs, comes out of Blalock Lake, about three quarters of a mile above my place in the NW¼ of the SW¼ of Section 26-7-35. Lower Cold Creek is a tributary of lower Mill Creek and lower Mill Creek runs into the Walla Walla River from the northeast in the NW¼ of Section 32-7-35. The creek runs through my place and is in between Mill Creek and the main stream. My place is located about a quarter of a mile south of the place where the old state road joins the new Walla Walla-Pasco highway and has a water right from Lower Cold Creek with a priority of 1895 as shown on page 86 of Washington's Exhibit 11. I moved on the place in 1908 and have lived on it ever since. I have a prune orchard of 2 acres, then we raise alfalfa and some garden stuff and tomatoes. Last year I raised tomatoes.

The water master first regulated my right on this stream in 1929. Prior to 1929 we had plenty of water so we could get along with it. We had water all season. There was no regulation. We would just go out and get the water whenever we wanted it. When the water master came on the stream in 1929, it was just too bad. We wouldn't get any water after the first of June only what we borrowed or bought, traded for or something, got from the neighbors. Since 1929 we have had to lease water from neighbors that had a prior right and wasn't using it. We just get it from year to year. We couldn't figure ahead. We would just get it maybe for this year and then we didn't know whether we was going to get it for next year or not. We would just take chances. If we were not able to get water from any other source, we would have to change our farming operations to dry farming practically. We have got to have water for orchards and gardens. I have been able to continue my farming operations because I have been able to lease water from older rights from year to year.

After the water master went on the stream, he would take water past my place for the use of others. Before the water master went on, I did not measure any water—just took it. I have a measuring box in my ditch now—put in after the water master went in. It is not possible for me to get water from the sewage disposal of the City of Walla Walla. Cold Creek is west of Gose Street and that point is below where Mill Creek goes dry every year.

RALPH R. HASTINGS, for the State of Washington, testified in part (177-182):

I live on lower Mill Creek, that part of Mill Creek

below Gose Street in the City of Walla Walla. Lower Mill Creek borders my place on the north. It has a water right for 30 acres from Mill Creek with a priority of 1896 as shown on page 86 of Washington Exhibit 11. My place joins the Cundiff place on the west. I have owned the place 11 years. I raise garden and vegetables. Prior to 1929, we had sufficiency of water to do our irrigating with. We got our entire irrigation supply from lower Mill Creek and used the water all summer. The water master began regulating my rights in 1929 and since has closed our ditches along in June. We have to lease water or borrow it from some older prior rights in order to carry on our garden. There is nothing permanent about it. It is just from one year to another. I have been able to do it so far, but how long it will continue, I don't know. If I were not able to get water from leasing or from other sources, I would not be able to carry on gardening. I would have to change to alfalfa or something—I could winter irrigate or something of that kind. When the water master takes the water away from me, he gives it to prior rights below or above me. Before the water master went on the stream prior to 1929, we took what water we needed. We didn't seem to be bothered. There seemed to be a sufficiency of water. They are not giving the prior rights more water than they used to. They are giving us what our decree calls for to a certain time of the year, then we are cut off. So far I have succeeded in leasing this water from the same person each year. I lease from George T. Welch, who has an old right on the main stream about a mile and a half above Lowden. He raises some alfalfa. He uses water to irrigate grease-wood pasture in the early part of the spring and does not

irrigate during the summer time. In order to raise crops on his land, I think he would have to wash the alkali out of it. I do not recall that there has been any development of irrigated land down the river since I went on my place. I think the Gardena district has put more acreage in.

WALTER SAMS, for the State of Washington, testified in part (184-190):

I live on the West Little Walla Walla River. This tributary rises in Oregon, flows across the state line in a northerly or northwesterly direction into the main stream. My land is in the State of Washington and lies about 400 feet from the stream. I have a water right for 26.6 acres from the West Little Walla Walla River with a priority of 1894 shown on page 81 of Washington Exhibit 11. I have lived on this place 26 years. I raise a little fruit, a little barley hay, a little alfalfa. The supply of water in the stream in the vicinity of my place in recent years as compared with the supply 10 or 15 years back, has been getting shorter from year to year. There has been a difference in the supply of water since 1929. The water master closes off my rights some time in June, about the middle. Prior to the regulation of the stream by the water master, I used to get plenty of water in the summer to irrigate my land. The regulation of the stream hurts my farming operations quite a little bit, got to raise something that grows in the spring. After July your ground gets too dry, you can't raise anything. I am raising just about 4 acres of alfalfa now. I used to raise about 16 or 17 acres as a rule. I plowed up 11 or 12 acres and seeded it to barley hay. It does not require water in the summer. You can get along with

a little water in the spring with that kind of a crop. I have been compelled to change my type of farming to adapt my farm to the smaller supply of water in the spring and the lack of water in the summer. Barley hay is a less profitable crop than the crops I had before. My alfalfa had been in three years when I plowed it up. It had begun to kill out, dried out more than anything. When the water master shuts off my water there is mighty little flowing in the stream—not near as much as there was when I would go and get it as I wanted it. The water supply had diminished. 1933 was a pretty good year but there wasn't quite a supply flowed down the stream when they cut my right off. The water flows right through my place to the lower people, but the West Little Walla Walla was practically shut off. The water master cut off my supply in 1933 about the middle of June—not later than in the other years—about the same time. My place is about three-quarters of a mile from the state line. There are quite a string of springs between my place and the state line. Those springs have diminished a little bit in their flow. They have not been increasing any. Prior to 1929 in the summer all my supply of water did not come from those springs. There used to be lots of water come across the state line. Not very much came across in the summer of 1933.

RALPH DANIELSON, for the State of Washington, testified in part (192-196):

I live on Titus Creek. My place is about a mile below where Titus Creek takes off from Mill Creek. Titus Creek is a sort of a branch of Mill Creek about three miles long. It takes out from Mill Creek above the Yellowhawk and returns to Mill Creek below the Yellow-

hawk. It is above the City of Walla Walla. The Baker ditch goes through my place and the Baker ditch is a branch of Titus Creek. My place has a water right for 10 acres from the creek with a priority of 1900 as shown on page 93 of Washington's Exhibit 11. I have lived on the place since 1925. With irrigation I grew corn the first two years and then berries and fruit and garden truck of any kind. When I didn't get water enough for a garden, I put it in alfalfa, and last year I didn't get water enough to bring that, so that was a loss. Prior to the regulation of this stream in 1929, we had all the water we could use. I just went out and helped myself. Since 1929, the water is shut off any time after the first of June. Since the regulation on the stream I haven't been able to get any water during the summer. The water that the water master takes away from me goes on down Mill Creek to prior rights under order of the water master. The water is regulated at the point where Titus Creek comes out of Mill Creek and then I have a weir at my ditch. There is a division box just below where Titus Creek comes out, where there is a return into Mill Creek.

CLIFFORD RIGGS, for the State of Washington, testified in part (198-234):

I am a dirt farmer. I reside in Gardena, an irrigation project a mile south of Touchet. I have resided in Gardena since 1907. I purchased 62 acres of land there in 1905 and now own 93. The land will not grow crops successfully without artificial irrigation. Originally the system of the Walla Walla Irrigation Company watered this land. Now it is the Gardena Farms District No. 13. I am one of the board of directors of the district.

When I went on the place in 1907, it was virgin bunch grass, sage brush, there were no improvements. I leveled the land for irrigation, put it in alfalfa and erected my buildings. I think the second year I had the entire 62 acres in alfalfa. I drilled a well, put in a water system to supply the farm in general. There were 3 or 4 families in Gardena then, now there are 80 families, some renters but mostly landowners. There are 4000 acres or such a matter in alfalfa in Gardena and also east of the siphon, the remaining acreage is in orchards, grain crops, corn and potatoes, rotation crops. The soil is deep and is all of a similar character and productivity. In the earlier stages of the development of the system, we for years got about 8 tons of alfalfa to the acre. It dwindled down to about 7 tons up to 1924. Since 1924 we have been producing less, at least 2 tons less, about 5 tons to the acre. It costs no more to produce 7 tons of alfalfa on an acre in Gardena than to produce 5 tons on the same acre. The cost of producing the crop would be equal plus the cost of the added tonnage put up. The (added tonnage) would be a small item. In fact, I question whether the cost would be any more or not. You take a short growth of alfalfa hay, it is very hard to handle and it will cost practically as much to put up a short crop as it will a normal heavy crop when the hay hangs together, cleans up good, where otherwise your time is wasted in clawing around in order to try to clean up the short hay. The extra 2 tons is practically all profit. I have dealt in alfalfa hay grown in Gardena to a certain extent and I am familiar with the average price per ton. With no exact figures to quote from (I would say) the average would be $10 or better per ton in the stack.

Since 1917 we have put in measuring devices and maintained a regular complete system of distribution. The water is efficiently distributed over the land. The corrugated system is used, no flooding. The irrigators are continuously with the water to take care of it. On certain laterals rotation is practiced.

Prior to 1924 there was a continuous service of water in Gardena proper during the summer months. The canal was never dry in the summer from 1907 when I moved on the place, except in times of breaks in the canal or of making repairs, until 1924. The canal became dry during the summer months in 1924 and has been dry part of the summer every year since then with the exception of 1933, last year. I do not know why in 1924 the Gardena canal went dry in the summer. There was no water in the Walla Walla River at the intake of the canal to furnish water for it that year.

In April, 1930, I took a trip up the river in Oregon and found the water was appropriated to other canals. The supply of water had diminished early and 5 or 6 of us water users went up and made an inspection of the river to ascertain the reason the water was becoming short at that time of year. We found the whole Walla Walla River (Tum-a-lum) dammed off so that the water from the main stream would go down the Hudson Bay ditch at that time. The fellows were standing in the Walla Walla River channel below fishing over into the Hudson Bay ditch.

I never measured the water in the canal. I don't know how much was being entered in the canal. I was interested in the amount I was getting, was why I made the investigation. I know that there was a shortage for

irrigation purposes. My farm had a shortage that year at that time and other farms of my neighbors in that vicinity (were) in the same condition. In 1929 there were about 4000 acres in cultivation (in the district). I couldn't state definitely as to the number of acres.

My place is situated due south from the Town of Touchet towards the lower end of the canal about 2 or 2½ miles west of the siphon. When the canal went dry in 1924, there was no water in it at my place. I didn't go and walk up the full length of the canal. I didn't walk the canal. I assumed there wasn't any water in the canal all along its length. I consider June, July and August as the summer months. As to whether there was water in the canal up until August 30 in 1932, I couldn't tell you the exact dates. I know the canal was dry.

I wouldn't state positively when the siphon was rebuilt. It was built in the fall of '25, '26 or '27, somewhere along in there. It was built under the supervision of Mr. Hartvedt, who has been water superintendent of the district since it was formed in 1928. They did not shut off the water supply during the irrigation season to build it. They waited until the irrigation season was over. A number of years the Gardena canal took sewage water from the City of Walla Walla. It was continued up to the year the disposal was put in at Walla Walla. I couldn't tell whether 1923 was the last year that we used any sewage water. When they quit using sewage water (in the canal), it would be hardly noticeable. That little (3 c. f. s.) didn't amount to anything.

We went up to investigate the water the latter part of April (1930). At that time we were short of water. The water was getting low in the canal. According to

the official measurement of the canal we had as much as 68 c. f. s. in the canal.

At that time I did not examine the diversions up Mill Creek. I didn't even look over the diversions on Yellowhawk or Garrison. I took no notations with me as to the priority dates or the rights of the parties in the matter at all.

In the average year, I would estimate that it costs $7 a ton to raise and put alfalfa in the stack. I have had no experience of raising alfalfa in any other place besides Gardena. I have not observed or in any way studied the raising of alfalfa in any other place. I do not know what the general experienec is as to the amount of production in other places.

The soil (in Gardena) raises very good fruit. Most of those who started raising fruit have taken their orchards out. A few years back they was hardly getting sufficient water. The market conditions, in cutting down the market price, has made it a financial problem and in a way some have solved it by taking out their orchards and going to alfalfa. I couldn't say that fruit raised in that section suffered from frost damage in blossom time any more than many other sections. We have had occasions of frost damage but that was pretty general. It wasn't only there, but other places. Our lands are situated a little differently. We are on a bench 60 or 75 feet, probably more than that, above the river lands in the valley. At one time there was a considerable plant of orchards in that project. Beginning about 1920 to 1922 the Walla Walla Irrigation Company commenced taking them out. I had 20 acres of apple orchard at one time and took it out in 1926 or '27. The taking out has been

so general that there are no commercial orchard tracts on the project now. The orchards have all been pulled out except 4 or 5 acres. I have got about 3 acres.

Whether there is a general dwindling down of the amount of alfalfa that is raised to the acre, after the production has reached the peak stage, depends upon the age of the alfalfa and the ability of the farmer but we have alfalfa fields there that's been in for 20 years and is in today and has been producing very good. The production of alfalfa requires a resetting in most cases in every 7, 8, or 10 years. I think it is profitable to reset your alfalfa every 10 years any way, and, in a good many cases, 5 or 6 years. Whether even by resetting there is a general reduction from the peak to an average level, I can't say. If your soil conditions are kept up, alfalfa is a soil builder. It may be true that alfalfa is not a soil builder for itself but for some other crop. I couldn't tell you exactly as to that (but) by reseeding your alfalfa, renewing it, you get a good yield if you have got sufficient moisture to produce it. The general practice in reseeding is some rotation of crop, potatoes and corn, principally potatoes. Alfalfa as a general rule hadn't been reset in 7 or 10 years up to the last few years. We have (had) winter freeze that has killed the alfalfa out to come extent, two different winters since 1922. About that time we had one period that froze out a part of the crop and last year it was a pretty general freeze out. When I say it froze out a part of it, I mean a certain area and part of the plants. There would be a few that wasn't affected at all, right at the midst of the district that was frozen on all sides. We practically only had two very serious winter kills.

Since 1924 we have gotten as high as $23.00 and as low as $7.00 a ton on board the cars at Touchet. Just one year, last year, was (alfalfa) $7.00 a ton on board the cars. The bailing cost is $2.50 a ton, the hauling 50 to 75 cents a ton. We have never had a year in which we were unable to sell alfalfa hay. There is about a normal consumption barring years like this (last year).

LEE H. SMITH, for the State of Washington, testified in part (236-252):

I have resided in Gardena since 1919. I purchased 63 acres developed with dwelling house and barn. All in alfalfa. I have grown corn, sugar beets, potatoes and hay and a nurse crop, reseeding that is, grain nurse crop. When I went there in 1919, there seemed to be plenty of water—that is, sufficient for summer. The pronounced shortage occurred in the fall of '24, the summer time. The canal had not been dry during the summer months from the time I went there in 1919 until the summer of '24, when it was dry. In '24 I had corn and late potatoes; I think I had sugar beets that year, too. I grew late potatoes until 1925. Since '25 have grown early potatoes. Back in '21, '22, in there, I was getting 250 one-hundred-pound sacks (of late potatoes) to the acre. In 1925, I had 15 acres of (late) potatoes in and my yield that year was 100 sacks to the acre. In '25 the ditch went dry and couldn't get water enough to set the potatoes or carry them through the hot weather which we formerly did before that. (In '25) there was a freeze in the east; I sold what potatoes I grew—I had 15 acres, 1500 sacks—for $2.50 f. o. b. the cars at digging time. If I had had my 200 or 250, it would have been a killing. I started growing potatoes in '22. There were

about 300 acres in potatoes in Gardena that year. It hasn't been the same since then. When the shortage of water came, that is, dropped off, why, of course they all had to go to early ones, and naturally some of them dropped off, or most of them, in fact, most of them. Last year we had 33 acres of early potatoes and we had 11 cars. That would be practically 300 one-hundred-pound sacks of No. 1 potatoes to the acre.

I would estimate that there were 3000, 3500, somewhere in there, of acres in alfalfa under the Gardena project in 1924. That number of acres has continued practically since. I have dealt in hay as a buyer and seller for 6, 7 or 8 years. I have been state deputy hay inspector. I heard Mr. Riggs' testimony on the effect on hay production since 1924. I have grown alfalfa myself. I have kept pretty close track of the production and I would say that since 1924 four tons per acre is nearer the average, possibly 4½. Previous to '24 the average production per acre run 6, 6½ to as high as 9. Of course, that is individual pieces, you see. I would say as an average of the lessening of production, at least, 2 tons per acre. We have found since '24, or the period after the ditch was going dry, that our third cutting being dry, the Russian thistles thrive on dry land. It is from lack of water. If the third cutting has plenty of moisture to grow, they won't come in, don't you see, and there is quite a considerable of Russian thistles come in the third cutting now. Before 1924 it was a common thing in the district to get four cuttings. Since '24, occasionally where you cut the second cutting real short, early, you get a fourth clipping, but it would be very light, for purposes of rabbit hay. That is the only in-

stance I have known of in a long while to have a fourth cutting.

Last year, '33, there was water pretty much all summer until September, that is a small amount for gardens and little stuff. There was an extra amount of rain in the district last season. From 1919 until '24, the canal was never dry in the summer that I know of. The main canal runs right by my place.

As a hay buyer, I have been familiar with the prices of hay since 1924. I believe it was '26 or '27, along in there, I paid as high as $24 a ton on board, one year. I sold it at one dollar a ton advance. Two years, I know it was $19 to the grower and last year (1933) it was the cheapest, approximately $7 to the grower. The minimum average price per ton for hay in the stack in Gardena in 1924 I would say (is) from $10 to $12. It wouldn't be less than $10, because there is only one year that it was sold for less than that.

The year 1925 was not a high water year down our way. I couldn't say whether there was more water went down the Walla Walla river in 1925 than any year since. There might have a lot of water went down early in the season, but along in July it was short. I don't think there were about 2000 acres added to the cultivation on the Gardena project (during) the next 2 or 3 years following 1919. It was pretty well all in. There was a few pieces going in, but not any great amount. There has been a slight increase, yes, but not any big increase that I know of. Really, I don't believe that there is very much of the bunch grass land that went in. They have been shifting around in those freezes and reseeding and having to grain a year and something like that, then seeding

it back but I don't know of much of any new stuff that has been put in.

In the summer months of 1919 I had enough water in the summer months, June, July and August, to get by on our perishable stuff. You see there usually wouldn't be over two or three hundred acres and by rotating you can get on smaller amounts. We irrigated our alfalfa in July (1919). We usually have had water some in July for our alfalfa. We didn't have any full head or big head or anything like that but we had water. There was water. When I went there in 1919, I think the usual run of the alfalfa growers irrigated their alfalfa in July, possibly not in the very latter part. I couldn't say whether they irrigated their alfalfa in August. I don't remember (whether) I irrigated my alfalfa in August (that year). I know that there was water in the canal the whole season. I had plenty of water in 1922. I don't remember if we irrigated our alfalfa, but I know I had 20 acres of potatoes and I got water in August for those, I couldn't remember whether I irrigated my alfalfa in July of that year. The potatoes and corn and perishables naturally would have the preference in the distributing of water. I suppose they gave them the preference. I don't remember. There was no regulation; it was just the consent of the users. In 1927 I discontinued the late potatoes. I did not get to irrigate them in July. In 1930, I did not irrigate my potatoes in July. I discontinued the late potatoes and was raising the early ones and they were through irrigating before that date.

C. P. HARTVEDT, for the State of Washington, testified in part (255-294):

I reside in Wal[illegible] Walla county. During the last 28

years I have been engaged in designing, constructing and operating irrigation projects in the State of Washington. From the year 1926 I have been in charge of the operation of the Gardena canal owned at this time by Gardena Farms District. When the Water Code was enacted in this state in 1917, I was the first water master appointed for this county under the Code. I held the position of water master for this county from the year 1917 to 1922 inclusive. At the time of my appointment, the rights of the Walla Walla River had not been adjudicated. There were no measuring devices on the stream. There was no attempt at regulation of the stream. We had no authority in fact to enforce regulation. The only weirs constructed in the stream system from 1917 to 1922 was at the Gardena canal, and for the flow which had to go on down the river. That was in the main river at the Gardena intake. During the whole period that I was water master, with the exception of the East Little Walla Walla, the tributaries of the main stream contributed no water to the main stream during the low water period. The Yellowhawk on the north did not contribute anything during the low water period. The McEvoy Spring Branch contributed very little, if any. In those years from 1917 to '22 (there) was a pretty good flow of water in the main stream right at the bridge in the Milton-Walla Walla state highway, and also in the East Little Walla Walla River. I used the bridge to observe the supply of water in the main stream. It was right on the highway. The supply in the East Little Walla Walla was from 10 to 15 c. f. s. I believe, at that time. I didn't measure it. That was just my observation. I know the water flowed down the main stream all summer from the

East Little Walla Walla. That was really all the supply that reached the point of the Gardena diversion. (It) came from the main stream and the East Little Walla Walla. On July 1, 1917, the Gardena canal was diverting 65 c. f. s. according to Washington Exhibit 18, page 13. It does not show any amount left in the river, but evidently it was practically all picked up until the 14th of July when the Gardena canal was diverting 47.54 c. f. s. (leaving) a balance in the river of 20 c. f. s. On August 1, Gardena canal 22.1, balance in the river 22.1 c. f. s. On September 1, Gardena canal, 18.15, balance in the river 20 c. f. s. Passing on to the year 1918, July 1 to 3 inclusive, Gardena canal 33.26; left in the river 21.33 c. f. s August 2nd to 5th, Gardena canal, 29.40; left in the river, 13.91 c. f. s. September 1st, Gardena canal, 29.40; left in the river, 12.06 c. f. s. Passing on to the year 1919, July 2nd, Gardena canal, 26.88; left in the river, 10.71 c. f. s. August 4th, Gardena canal 13; left in the river, 9.72 c. f. s. September 1st, Gardena canal, 9.10; left in the river, 12.42 c. f. s. Passing on into the year 1922, July 1st, Gardena canal, 34.58; left in the river, 12.76. At this date the canal received 3.08 c. f. s. sewage. On August 3rd, Gardena canal, 16.10; left in the river 11.34 c. f. s. and the sewage remains the same. September 1st, Gardena canal, 30.66; left in the river, 1.60 c. f. s. There was a supply in the main stream generally throughout the summer for the use of the Gardena canal and lower users below.

I was away from Walla Walla county from the fall of '22 until the fall of 1925. Upon my return (in 1925) I took charge of the operation of the Gardena canal and have been continuously in charge since. Upon my return

I had occasion to observe the supply of the stream duri the low water period. There was a very noticeab change in the summer supply. (There was) very muc less water in the river at the state highway bridge. Sin that time the water has been very much less every ye during the summer. (The river) practically goes dr there in the summer time. The supply of the East Litt Walla Walla in recent years is much less than it was fo merly. Even with the shutting off of the rights on th East Little Walla Walla in recent years the supply goin down (to) the main stream does not exceed 5 c. f. s. du ing the low period.

In 1917 I became superintendent of the Garden project, (then operated by) the Walla Walla Irrigatio Company. At that time the canal system was in fai condition but they had no measuring weirs. I complete the installation of weirs by July 1st, that year. Sinc 1917 all water has been measured to the users. When I took charge in 1917 some repairs were being made o the siphon by the Irrigation Company. I had nothing t do with the repairing but in the fall of that year, I re newed about 2000 feet, and renewed or repaired it fro year to year as necessary. When Gardena Farms Di trict No. 13 took over the system, I continued on as super intendent and am still with them. I had full charge o the construction of the new siphon—I purchased the ma terial, employed the men, and supervised the work. I constructed the diversion works in the fall of 1917. It was all constructed of concrete except the apron, which was of timber. And since the district became the owner, we have constructed a concrete apron on the diversion dam. The Gardena District irrigation system is now in

very good condition. In comparison with other diversion works and irrigation systems on the Walla Walla River and its tributaries, I believe it is far the most up-to-date system in the valley.

There are Class A and Class B rights on the Gardena irrigation system. The lands with a Class A right were those having a water right sold by the Walla Walla Irrigation Company prior to 1917. (Some) rights were exchanged for rights of way. Lands with a Class B right are those that in 1917 were owned by the Company. In case of water shortage in the low water period, Class A lands have a preference.

From 1917 until I left (in 1922), the Class B rights got water for a longer period in the summer than they got after my return in 1926. The Class B lands were affected the same as the Class A lands as to production because of the water being shut off sooner. If they don't get water after they get their first crop of hay off, the production is very light and that has happened since I have been back this last time. Last year we delivered water to 2,245.5 acres of Class A lands. That has been the acreage over a period of years.

The sewage of the City of Walla Walla conveyed to the Gardena canal never attained a greater quantity than 3.08 c. f. s. They discontinued the use (of the sewage) in the late '20s.

I heard the testimony of Mr. Clifford Riggs about an inspection of a dam in Oregon at the intake of the Milton-Freewater and Hudson Bay Irrigation Company's canal out of the Tum-a-lum. I made an inspection of that dam in April, 1930. They have a concrete diversion dam—it is pretty well covered with gravel but they put

planks on and close it up tight, so that all the water can be diverted down through the Hudson Bay canal. It dammed off practically all the water in the main stream at that time—a little leakage went through. (This dam) is at what we call the Nursery Bridge, right below the railroad bridge. The diversion of the Milton-Freewater and Hudson Bay Irrigation Company out of the Tum-a-lum runs west and joins the Little Walla Walla, and comes out of it a little further down. It was my belief when I was here from 1917 to 1922 that their point of diversion was entirely from the Tum-a-lum. The Milton-Freewater and Hudson Bay Irrigation Company employed me to construct a weir in their canal just before it joins the Little Walla Walla and it was my understanding that they were required to keep measurements there and divert the same amount from the Little Walla Walla down at the Frog. That is why a weir was installed there. Mr. Burlingame had the controlling stock of the Hudson Bay Company at that time. He (also) owned the Walla Walla Irrigation Company at the same time. By mutual agreement between the two companies, from 1918 to '22, I used to shut off the Hudson Bay diversion for the Gardena canal.

The Gardena canal didn't go dry at any time in the summer (from 1917) up to the time I left in 1922. It went dry in the summer of 1926. I don't know what happened in '24 or '25. I was not there.

On cross-examination by Mr. Cochran, counsel for the State of Oregon, Mr. Hartvedt testified in part (273):

When I went up in April, 1930, to see what was causing the shortage of water to Gardena, no water was turned down as a result of that visit. During April,

1930, the Hudson Bay was diverting 68 c. f. s. and beginning in May, 70 c. f. s. was diverted. The supply for Gardena on April 22 was 68 c. f. s. On May 14 it increased to 71 c. f. s. and on May 22 to 99 c. f. s. A big rain came on June 2nd and the (Gardena) diversion was increased to 107 c. f. s. At that time in 1930, 5631 acres were under contract with the Gardena project. There has been no change in the amount of land since 1930. In 1933—that was about the same acreage as in 1930, we delivered water to 5445 acres. Some of those acres might not have been all in, but nevertheless (we) delivered water for that amount of acres. Under our decree, we were entitled to 75 c. f. s. in May, 1930, I believe. The most we have carried (in the canal) is 132 c. f. s. but we spilled a proportion of that out of the spillway. The exact acreage irrigated in 1933, according to Stipulation No. 5, was 5,204.51. That amount of acreage would allow us 69.38 c. f. s. but we are delivering the full amount. Say 80 acres of land, the individual may require only 70 but he gets 80 acres of water; he is paying for it. The decree doesn't limit the amount of water to each individual. I don't believe the district would have any authority to do that. In place of limiting a water user to the actual acres, according to the duty of water as given by our decree, we give him the amount he pays for, the amount that is on the assessment roll. If he calls for his water, he receives it, if we can furnish it, regardless of how much he has under irrigation. If he wastes it, of course, we close it down. The district notifies the State Hydraulic (Engineer) and the water master as to the number of acres we propose to irrigate the following year, and that is what we receive water for. In arriving

at the number of acres for the certificate to the Hydraulic Engineer, we simply take the number of acres that is paid for upon the assessment roll. We don't know when they are putting in this additional land. Like this year, there are a few pieces owned by the company and they are putting in all their odds and ends this year. From 1926 down to the present time, there has been some increase in the land irrigated, not very much. From 1919 to 1920, the Walla Walla Irrigation Company improved a considerable acreage of their lands. I believe (there) must have been some other company owned land that is not included in your Stipulation No. 5 (for 1919) because there has not been any great amount of land improved the last few years. There have not been times when there were contracts outstanding that were not being used, that I know of. That isn't the case at the present time. In 1933 there were 216.56 acres being paid for (but) not being irrigated. That is what we call the (Walla Walla Irrigation) Company lands. Then there is about 15.45 acres of company lands in Oregon not irrigated, payments are being made on it. That is being put in alfalfa this year. The company lands are owned by people who have foreclosed the mortgage. The water right was attached to those lands by the company (before) they issued the mortgage. There is no individual down there that owns lands not irrigating it, except one 20-acre tract owned by John Merry and there is a 115-acre tract owned by Mr. Rowen and the Federal Land Bank foreclosed; there is some of that land that wasn't irrigated last year.

In 1918 Mr. Burlingame and I went up to the Hudson Bay headgate at the Nursery Bridge and turned

water from the Hudson Bay diversion down the Tum-a-lum. I couldn't tell the date because I didn't keep any record of that. I don't remember now exact dates, but anyway it was when the stream flow commenced to get less. It was probably the latter part of June. I couldn't tell how long they permitted it to run there because I had lots of work to do those days and I didn't get back there very often. As to what time they turned the water down in 1919, I would have to make the same statement for that year because I have no dates. Burlingame went up with me two or three different times and then he had a patrolman there—the man that is on there now—I can't recall his name. The ditch walker of Hudson Bay, Bowman. As to what time I went up there and turned the water down in 1920, I make the same statement for that year. I kept no record of it when I did turn that down. It was before the 23rd day of June, when they closed down the Hudson Bay ditch. It was when the water got short in the river. I believe 1920 was a short water year. The water ran down that particular stream bed, the Tum-a-lum stream bed, and it always reached the Gardena canal the following day. This water was turned down the channel, understand, before the stream bed was dried up. After the stream bed is dried up it will take many days. If my memory doesn't fail me, we practiced that every year. At that time Mr. Burlingame had the controlling interest in both companies. I think he tried to be fair in attempting to adjust the water so as to furnish water for both. I did not measure the water that was turned down—just a guess. We have no record to show. In 1930 when I went up there no water was turned down. In 1930 Mr. Burlingame had lost control

of the Gardena project. He still owned a considerable amount of land. He still had control of the Hudson Bay. The increase in the supply of water occurring in May, 1930, as shown on page 21 of Exhibit 18, was not occasioned by any turning down of water by the Hudson Bay. I have no record that shows the increase of the water supply by reason of water having been turned down, in the Gardena canal. It wouldn't show the full amount of the turn-in, you understand, from the Hudson Bay, it wouldn't show up at the Gardena intake the following morning, but we did know that there was an increase, but it would run for—it would sort of balance up, drain out the pond in the Tum-a-lum section. We have no record that would show as to the amount in acre feet that was coming through. The increase from that source would be hard to tell, the condition of that stream, in 24 hours. It is a material change. The measurements on the Gardena canal for 1918 shown on page 15 of Exhibit 18 shows a diminshing flow in the Gardena canal from the 10th of June down. On page 17 (of Exhibit 18) for 1919, we have the same condition, a diminishing flow in the Gardena canal during June. On page 19 (of Exhibit 18) the measurements for 1922 show a diminishing flow the latter half of June but an increase on the 28th. I testified that when I came back in 1926 I noticed a very material reduction in the amount of water that was being carried in the canal in July and August, especially August, than was carried in the same months in 1919. On June 29, 1926, there was 16 c. f. s. After that the canal went dry. On July 22, 1927, we have a measurement of 14 c. f. s. in the canal and 7 (c. f. s) in the river. On July 21, 1919, there was 15 c. f. s. (in the canal), left in

the river 9 (c. f. s.), about 25 c. f. s. in the river on that date. I know the Gardena canal went dry at that time from 1926 on until last year, and prior to 1922 it did not go dry. In 1928, on June 23, there were 25 c. f. s. in the canal and 13 left in the river, making 38 c. f. s. On June 22 in 1919, there were 36.74 c. f. s. in the canal, 11 c. f. s. more than on June 23, 1928. There are no measurements after the 23rd. The canal may have run 3 or 4 days after June 23rd (in 1928) before I went back and it was closed off to supply prior rights down the river. In 1929 the canal went dry on July 15. That was because of the regulation of the water master under the Walla Walla adjudication decree. We were cut off to supply prior rights lower on the river. When I was first appointed water master in 1917, it was part of my duties to enforce the decree in the Lowden Case against the Gardena people. I was at the same time superintendent of the Gardena project.

The number of acres of the Class B rights under the Gardena canal is the balance between 2245.5 and 5631.31 (3385.81). Except as between themselves, the owners of A and B rights in Gardena have the same priority as against third persons. The priority between the irrigators there resulted from a proceeding before the Public Service Commission of the State of Washington. I was sent there by the Commission to put in measuring devices and distribute the water and make a recommendation as to duty of water and change of the irrigation season. The old original contract provided for irrigation season to begin April 1st and end November 1st each year, and they found it more desirable to start the irri-

gation season March 1st, simply because it is an early country.

The Public Service Commission did not enter an order but the understanding was that the lands that had been issued the water rights up to that time should have the preference in water.

On redirect examination, Mr. Hartvedt testified in part (294):

In my answer to the question whether or not the water passed through the Tum-a-lum when I shut off the Hudson Bay canal, I said "No." I didn't mean that. It did go through simply because the stream channel hadn't been allowed to dry up before we turned the water down.

With respect to Class A rights, when I went to Gardena at the request of the Public Service Commission in 1917, 2245 acres had been sold by the Walla Walla Irrigation Company and these were considered as Class A rights and lands that was held by the company was treated as company lands, and, as I stated before, if there was a shortage of water, those company lands took the shortage. After that was fixed, when those lands belonging to the company were sold to individuals, they continued to take a Class B water right and were treated as such.

JAMES G. WOODBURN, for the State of Washington, testified in part (312-425, 1179-1187):

I have the degrees of B. A. and M. A. from Indiana State University and the degree of B. S. in Civil Engineering from Purdue University. I also have the degree of Ph. D. in Hydraulic Engineering from the University

of Michigan. I spent two years in graduate study in Hydraulic Engineering at the University of Michigan. I was a Freeman Traveling Scholar studying Hydraulic Engineering in Europe from July, 1929, to August of 1930. Since 1930 I have been Associate Professor of Hydraulic Engineering at the State College of Washington. I hold that position at this time. When I first came west in 1924, Dr. Waller of the State College of Washington was working on studies in regard to the irrigation of the Columbia Basin, and I assisted on certain phases of his investigation at that time. I am an associate member of the American Society of Civil Engineers.

I have made a study of the Walla Walla River system with the idea of reaching some conclusions as to the available supply of the river. I first came to the Walla Walla project in June, 1932, for the purpose of making those engineering studies, and since that time I have spent parts or all of a great many days on this work. During the summer of 1932, I spent two entire months in field work and office work, computations, and during the summer of 1933, I also spent two entire months on this study. During the winter I have spent considerable time on computations, with some additional trips to the field to look up and check points in doubt as they arose during the studies. All of the stream flow records of Walla Walla River and Mill Creek, I have looked up and studied for the purpose of determining the available supply of water and of supplementing the measurements and tests which were made during the past two years. I have also had access to the measurements that were cooperatively made in the last two years between the two states—not only have had access to them but assisted in

making the measurements, and to some extent, to a considerable extent, directed the making of those measurements.

At this point the following occurred with respect to designations on the map (Washington Exhibit 17):

THE SPECIAL MASTER: Gentlemen, as the witness proceeds with his testimony upon this map would it be satisfactory if he makes such designations upon the map—when he refers in the record to a particular point may (he) mark it (in red) so we may turn to his testimony and know what he is talking about?

MR. COCHRAN: I think that is a very good suggestion.

THE SPECIAL MASTER: If the witness will do that—if the data is not shown upon the map if you will just take the liberty, Dr. Woodburn, of making a notation on the map—for instance, the point to which I address myself is marked X,—and put an X upon the map.

The witness then resumed:

I will first describe the project in a general way and then come down to particular details.

The water which is used for irrigation in that part of the project of the Walla Walla valley in question comes from two chief sources; one is the Walla Walla River, which is fed by the south fork and the north fork, the south fork being the largest.

The Walla Walla River rises in two forks in the Blue Mountains, flows in a southwesterly direction, in a westerly direction and northwesterly direction, the junction of the forks being in section 22, township 5 north, range 36 east. From that point the Walla Walla River flows westerly, then northwesterly to Milton, Oregon, where

it divides into distributaries, one of the main distributaries of which is called the Little Walla Walla River.

The main Walla Walla River flows north from the branch of the Little Walla Walla through the east edge of Freewater and thence northerly to the state line. There it turns abruptly to the northwest and after a flow of about five or six miles to the northwest it turns to the west and flows to the Columbia River at Wallula.

The principal tributary of the Walla Walla River is Mill Creek, which rises in the Blue Mountains only a few miles from the headwaters of the north and south forks of the Walla Walla River, and flows for some distance in the state of Oregon, thence turns to the northwest and flows across the state line into Washington, thence further to the northwest, thence to the west, and thence somewhat to the southwest, to its mouth in the Walla Walla River in section 31, township 7 north, range 35 east.

The nature of the flow of the Walla Walla River and its forks and in Mill Creek is quite similar. Both streams flow for some distance from their source through narrow canyons which on their lower reaches are filled to some depth with gravel and boulders and local deposits of silt.

Through the canyons below point marked "A" on the Walla Walla River and below the state line on Mill Creek there are some irrigated tracts which take water from the respective streams.

The tributaries of the Walla Walla River other than Mill Creek are minor in character, particularly during the low water season, and contribute a smaller supply to the flow of the Walla Walla River, so as to be practically

negligible, at least during the summer season. Those tributaries are Couse Creek and Birch Creek in Oregon, and Cottonwood, Reser, Russell and Dry Creeks in Washington. These creeks are all noted on the map.

The streams, the Walla Walla River and Mill Creek, are fed during the low water season almost entirely from ground water flow, because of the scarcity of rainfall during the summer season. Their source is in the springs and ground water, seepage flow in the Blue Mountains, augmented during their courses down the valley. Both streams after flowing through their canyons, which gradually widen, emerge suddenly on to broad, alluvial fans, which have been built up by those streams by the debris which they have brought down from the mountains.

Both streams flow across those alluvial fans; and around the lower fringes of the fans, in addition to the streams themselves there are many natural gravity springs which drain the water from those alluvial fans and which return them again to the Walla Walla River.

The water emerging thus from the Mill Creek fan is so situated that it can be used for irrigation on the lower lands of the project. It extends as far as the western end of the Gardena tracts southwest of Touchet.

The water emerging from the Walla Walla River fan in Oregon, however, can only partly be used on the lands in question, because the water which emerges in springs on the western end of that alluvial fan is too far west to be so used. Only the water emerging from the Walla Walla River fan in the eastern part can be so used on lands having rights on the lower Walla Walla River, which river is the chief source of the ground water supply.

According to investigations as far as they can go back, there have always been springs around the fringes of the deltas in both Mill Creek drainage and Walla Walla River drainage. The springs have been shown to vary directly with the flow of the Walla Walla River, which is dependent on the precipitation in the mountains, to some extent the precipitation over the lower valley, and particularly on the snowfall in the mountains during the winter season.

I might point out in that connection that any change, artificial or otherwise, in the regimen of the flow of Mill Creek or of the Walla Walla River, particularly the Walla Walla River, which creates less water in or on the eastern part of the alluvial fan and increases the supply in the western part, thereby diverts water past intakes in Washington for rights on the Walla Walla River.

With that general survey of the project, I will go back up to the headwaters above all irrigation on both Mill Creek and the Walla Walla River and progressing down the stream point out the nature of the diversions and the disposition of the water supply.

First, on Mill Creek, because it is simpler, the Walla Walla city intake is in Oregon and diverts water to the house at which it is measured approximately at the state line. There is there a measuring weir for measuring the diversion for the city of Walla Walla. That diversion goes by pipe line to the reservoir shown here, from which it is distributed to the city; and the unused part, that is, the part that is not required by the city, depending on the supply required from hour to hour, the unused part is returned to the Mill Creek above the mouth of Yellowhawk, the spillway being shown on the map.

The supply of water furnished the city is measured by Venturi meter on the supply line. Below the state line on Mill Creek there are a few diversions for irrigating tracts. Those are shown on the map.

There are one or two very small and insignificant tributaries which flow practically no water in the summer.

At the mouth of Mill Creek canyon, or somewhat above the mouth, Titus Creek leaves Mill Creek to the right and flows for some distance through irrigated lands, with a return to the river at the lower end of Titus Creek.

Just below Titus Creek, about a mile below the head of Titus Creek, Yellowhawk Creek leaves Mill Creek to the left and just below that leaving, Garrison Creek leaves Yellowhawk Creek to the right, and these three streams, Mill Creek, Garrison Creek and Yellowhawk Creek, flow in approximately parallel channels to their mouths in the Walla Walla River, the first being Yellowhawk Creek, the second being Garrison Creek, and the third being Mill Creek.

The city of Walla Walla is about on the center or the lower part of the alluvial fan of Mill creek.

Returning now up to the forks of the Walla Walla River, from these points marked A on the map there are small irrigated tracts in the narrow canyon valleys where silt deposits have made farming possible. These are local silt deposits on benches which have been deposited by previous flood periods of the stream which have been greater than anything which has been measured in historical times, because if the flood had been great enough to be over and cover those lands it would have taken the soil off rather than depositing soil, unless the flood had

been great enough to have a slow enough velocity to deposit soil on those bench lands.

These diversions coming down the south fork and coming down the north fork are in the nature of small individual ditches in which, apparently each irrigator goes to the stream and scrapes out his ditch and piles in rock in order to turn water into his ditch which will take water to his small tract of land.

At the upper end of the irrigated area the canyon is from fifty to a hundred yards wide at the widest, and that width gradually increases until at the mouth of South Fork the South Fork canyon is possibly three hundred yards wide, and the North Fork canyon is maybe a hundred and fifty yards wide.

By far the larger percentage of the water comes from the South Fork, as will be shown in later records. I have been to the head of irrigation on the South Fork and to the head of irrigation and somewhat beyond the head of irrigation on the North Fork, and have investigated most of the ditches on the South Fork and have supervised measurements of all the ditches and scouted the North Fork completely for all diversions.

On the South Fork, for instance, diversions, starting from 17, will enter one of the tables which I have computed. Diversion 17 is called the Poulsen, (spelling) P-o-u-l-s-e-n, according to my copy of the Oregon decree. In some of the records the name of this diversion is spelled P*a*ulsen but in the copy of the decree which I inspected it reads Poulsen and it is carried in my datum as Poulsen. The Poulsen diversion takes water from the right bank of South Fork by means of a rock and gravel embankment, which has apparently been built in

rough and ready manner, conducts water for some hundred yards parallel to the county road and distributes water then to a small tract of ground which is cultivated.

Proceeding down stream, the next diversion is what I have referred to as the Hopkins Ditch, according to local testimony on the ground and to several of the rights as indicated in the Oregon decree naming that the Hopkins Ditch. There are other names for all of these ditches. I have taken the most commonly used.

The Hopkins Ditch, therefore, Number 18, diverts water from the right bank of the South Fork, conducts it through a rather thicket of cottonwood trees to a point at which there is a turnout to the left for an irrigated tract, the main ditch proceeding away from the river to irrigate lands down stream for over a mile.

The waters of the Hopkins Ditch are, apparently, as far as I could find out by inspection on the ground, mingled with the waters of the next succeeding ditch, No. 19, which I have called the Rhuberg-Powell Ditch. These waters are also mingled with a small diversion, No. 20, which I have called the Gray-D[illegible]aris Ditch. These are all ditches which divert water directly from the river with no control works other than manual labor of dropping rocks or boulders or gravel into the river or raking it out to adjust the flow of water in the ditches.

Just above the mouth of the South Fork is the next ditch which I might mention, the Dorothy Ditch, which diverts water to the left of the South Fork.

About a mile above the mouth of the North Fork is the Bowlus Ditch, which diverts water by means of a kind of a timber crib held down with rock into a gravel chan-

nel, which conducts water for some rods to the head of the irrigation of the lands under the Bowlus Ditch.

I will take up these ditches all more in detail later, in regard to amounts of water and acreages.

Just below the forks, in a position slightly different than shown on this map, due to a change through the flood conditions last year, diversion No. 24 leaves the combined Walla Walla River, that is, the two forks are now combined—the Demaris Ditch, diversion No. 24, takes out to the left by means of a timber, log and rock dam filled in and stopped up with some brush and grass and irrigates lands on the left bank of the river which have been formed by a rather wider bench now than the benches in the forks.

The next diversion I will mention is the Spence diversion, No. 40 on the map, which diverts water by means of a log and rock dam into a wooden flume, thence through conduit under the highway, thence into kind of a distributing box, from which there is a return to the Walla Walla River directly, the water for irrigation being diverted to the right from that point into an earth ditch, from which it flows to the lands irrigated by that ditch, which extend for nearly a mile down stream from that point.

The Zell Ditch, the next number, 42, is formed by removing rock and gravel from the head of the ditch and piling it on the down-stream side, so that the water will be diverted into the ditch. This ditch diverts from the right bank of the Walla Walla River and conducts water about seventy-five yards to a wooden sluiceway, at which point a return goes directly to the Walla Walla River, for waste water, and the main ditch is carried to the

head of the lands which are irrigated thereby. At that point there is a concrete box which divides the water into three ditches and which was used for the purpose of measurement this past summer. This is not really a weir, but it approximated weirs so closely that we considered that we would get fair results by its use for purposes of measurement. From this concrete divide the water enters various ditches and is conducted over the project, which extends for over a mile from the intake from the river.

We come now to the Milton power plant and the division of the water at that point. I have said nothing yet in regard to power diversions.

The Pacific Power & Light Company has a right on the South Fork, water for which they take out at about the head of irrigation and conduct through a pipe line to their power plant in section 26, township 5 north, range 36 east, where it is returned to the river. The length of the pipe line is about 7 miles. The location of the power plant is not located on the map (Washington Exhibit 17). I am not sure of the forty which it is in and therefore I can't locate it exactly, but they show the pipe line and at the end of the pipe line, approximately, is the power plant.

In section 22, township 5 north, range 36 east, the city of Milton diverts water from the South Fork for power use in section 18, township 5 north, range 36 east. This water is conducted to a standpipe on the hill above the plant referred to as the new Milton power plant, from which it either spills directly back to the river or is conducted through the turbines of the power plant. From the power plant the water may return di-

rectly to the river, but part of it enters a tail race of the power plant, from which by a wood-stave pipe it is conducted to what is called the old Milton power plant in section 12, township 5 north, range 35 east.

The Milton city pipe also takes its supply of water at the Milton power plant. That is the new power plant. The Milton city pipe for municipal purposes has its intake at the new Milton power plant.

A short distance below the new Milton power plant is the mouth of Couse Creek, which I have already mentioned as being during the low water season not significant.

A short distance below the mouth of Couse Creek is the intake of the Milton Ditch. The Milton Ditch diverts from the river by means of a dam constructed of logs or rocks or such materials as are on the site, and flows for maybe a hundred yards to the intake of a pipe line, at which point some water from the Milton Ditch spills back into the river.

The Milton Ditch water is conducted through about two hundred feet of this pipe line, crossing under the power line from the new Milton power plant to the old Milton power plant and emerging in an open ditch which flows along the southwest wall of the canyon, with some small turnouts for irrigation a short distance below this end of the pipe line, and then the ditch flows away from the southwest side of the canyon out into the more open lands, and there are between the head of the Milton Ditch at the river and the northwest quarter of the southwest quarter of section 12, township 5, range 35 east, there are between those points several small diversions.

This stream in that course has through part of its distance the appearance of being a natural channel; through other parts of that distance, however, it has the appearance of having been artifically constructed or improved or worked upon.

In that quarter-quarter section just mentioned of Section 12 the Milton Ditch makes an abrupt turn to the left and at that point there is a spillway running from the Milton Ditch to what is known as the Miller headrace, which takes off of the Walla Walla River at the bridge which is locally known as the Up-the-River Bridge, in the northeast quarter of the southeast quarter of section 12, township 5 north, range 35 east.

Just below the point on the Milton Ditch where this spillway leaves to join the Miller millrace is a measuring weir, which is about one mile by ditch from the intake of the Milton ditch from the Walla Walla River, and in that mile are several diversion turnouts. And from the weir the Milton Ditch flows through the City of Milton and irrigates lands as far west as the center of section 3, township 5 north, range 35 east.

We will return now to the water which came from the Walla Walla River by the way of the new Milton power plant, and that which is diverted from the Walla Walla River through the Miller millrace. Those two flows join and from that combined flow there are two diversions and a return to the Walla Walla River. The two diversions are the Miller mill flume and the McIntyre Ditch. The Miller mill flume conducts water to the Miller mill, shown on the map in the southwest quarter of the northeast quarter of section 12. From the Miller mill the tailrace conducts this water to the Little Walla Walla

River, which leaves the Walla Walla River at the Red Bridge, so marked on the map.

The water of the Miller millrace does not, therefore, return to the Walla Walla River, because the cross connection shown below the Miller millrace at all times at which I have been there, of which there have been a good many, has been dry.

The water then from the Miller millrace joins the diversion into the Little Walla Walla River and proceeds as Little Walla Walla River (water) from that point.

My second mark on the map (Washington Exhibit 17) was the cross connection from the Little Walla Walla River to the Walla Walla, which I have shown dry. It is indicated on the map.

At this point the following occurred:

THE SPECIAL MASTER: And that is in what color? A. I have been making these marks in red. Is that all right?

THE SPECIAL MASTER: Yes, so that all marks made upon the map are not a part of the exhibit; it merely illustrates the testimony and it may be considered testimony. The Doctor's marks are red, and we may then permit opposing counsel to use a designating color of their own.

The witness resumed (330):

I mark that because the map as it is shown here indicates a considerable stream of water, by width of line indicates as much water flowing there as in the Walla Walla River or in the Little Walla Walla River, while actually during low water periods at all times at which that has been investigated that cross connection is dry and there is no flow.

Between that point and what is called The Frog there are a number of diversions from the Little Walla Walla River. These are by small ditch or by water wheel, and there are also two rather important ditches which take out in that reach, called the Stillman Ditch and the Perkins Ditch, which will be mentioned later.

Returning now to the main Walla Walla River, from which the Little Walla Walla River has obtained water by direct diversion and through the Miller millrace, the main Walla Walla River flows north from that point, with a few small diversions, to the bridge called the Nursery Bridge. At that point concrete headgates divert water, when there is water available, for the Hudson Bay canal. I will mention that later and connect it into the general flow.

The main Walla Walla River channel then goes to the north from that point with very little diversion therefrom to the state line.

The Little Walla Walla River, as I mentioned, is now brought down to the position, to the point, known as The Frog. At this point the Hudson Bay intake joins the Little Walla Walla River and their waters mingle in the same general channel. That is the Hudson Bay intake from the main Walla Walla enters the Little Walla Walla River and that becomes the channel for the Hudson Bay for a distance of possibly a hundred feet. The (Little) Walla Walla River just above the entrance of the Hudson Bay water passes partly through the Peacock Mill. Water is diverted for the Peacock Mill from the Little Walla Walla River, goes through the mill and is returned to the Little Walla Walla River at approximately the point where the Hudson Bay canal enters the Little Walla

Walla River. There are, therefore, flowing into The Frog three sources of water, the tailrace of the Peacock Mill, the water which is left in the channel of the Little Walla Walla River, and the intake of the Hudson Bay canal from the Tum-a-lum. The Peacock Mill is not located on the map.

The Tum-a-lum is that stretch of the Walla Walla River in Oregon locally called the Tum-a-lum. The Frog has an artificial method of distribution of water in the form of concrete structures. The Frog is so named because there are three streams feeding in and as many as nine streams feeding out. Naming them in general from east to west, the streams leaving the Frog (are) the Crockett Branch (being) the most easterly division, the Ford Branch (being) the center division and the Hudson Bay canal (being) the most westerly division.

Now, in turn, the most easterly division, the Crockett, divides just below the Frog into two parts, one called the East Crockett branch, the other called the West or Main Crockett branch, shown on the map.

From the middle division, or Ford branch, there takes off a short distance below the Frog to the left the Pleasant View-Powell canal.

The other, westerly division, the Hudson Bay canal, flows away from the Frog without division.

At the Frog are also three orifices which divert a small amount of water for land immediately adjoining the Frog, which are not in any way main diversions; they are merely individual irrigators, merely orifices, or a weir for local diversion.

I will repeat, the main streams flowing out from the Frog are the east branch of the Crockett, the west or main branch of the Crockett, the Ford branch, the Pleasant View-Powell canal, and the Hudson Bay canal.

The East Crockett branch turns at right angles from the Main Crockett, and through most of its course it follows fence and property lines and road lines, making right-angle turns, apparently mostly artificially constructed.

The West or Main Crockett branch flows through a good part of its course in what appear to be rather natural channels, although within the last year a quarter-mile north of the center line of section 35 the Main Crockett channel has been revised to form a straight line across at least a forty-acre tract to avoid a winding, more natural appearing channel in which it flowed last summer and the summer before.

At the center line of section 35 the west branch of the West Crockett leaves the West Crockett to the left, and flows in a northwesterly direction to the center of section 26, whence it flows westerly and does not rejoin the west branch of the Crockett.

This channel through part of its length has the appearance of being rather a natural stream, but through the lower reaches is on property lines and makes right-angle turns.

At the south edge of section 26 another branch takes off from the West Crockett to the left; it is called the West Branch Crockett. This branch, the West Crockett and East Crockett channels, are united about one-quarter mile north of the center of section 26 and from there the

combined channels conduct water to the channel which is known as the East Prong Little Walla Walla Spring Branch, marked on the map "East Prong Spring Branch."

From there the water flows through a region in which there are springs and seepage waters through the state line, at which point it becomes known as the East Little Walla Walla, and from that point flows to join the Walla Walla River in the northeast quarter of the northeast quarter of section 10, township 6 north, range 35 east.

Returning to the Ford branch, at the Frog, that is the middle of the three divisions of the Frog, the Ford branch after the Pleasant View-Powell ditch leaves to the left, flows in a northwesterly direction across sections 35, 26 and 27. At the south edge of section 26 a channel is shown diverting to the right from the Ford branch and joining the west branch of the West Crockett at the center of section 26.

The Ford branch and the West Branch of the West Crockett flow northerly and westerly across sections 26 and 27—across the north half of sections 26 and 27—and are united then in the head of the channel known as the West Prong of the Little Walla Walla River.

This channel flows then through an area of springs and seepage to the state line, at which point it becomes known as the West Little Walla Walla River and flows into the Walla Walla River in the Whitman Mission Donation claim, as shown on the map.

I have mentioned now the three streams which conduct water, at least during the season of heavy flow of

the Walla Walla River. Those three streams conduct water into the state of Washington from the surface supply of the Walla Walla River in Oregon.

Below the fringe of the gravel delta are these regions of springs and seepage which I will mention in connection with the flow of those streams.

There are two distinct spring branches in there, so-called, which have their source throughout the entire year in springs, and which also flow northerly into the state of Washington across the state line. Those are known as the Big Spring branch and the Little Walla Walla or Ballou Spring branch.

The Big Spring branch conducts water throughout the year into the state of Washington, as far as I have observed.

The Little Walla Walla or Ballou Spring branch is mostly used for irrigation in Oregon, but it supplies some water to the state of Washington through the Hoffman ditch, which was mentioned yesterday or the day before yesterday.

Those are the sources of water flow across the state line into the state of Washington.

Reading from east to west: The Walla Walla River, or Tum-a-lum; the Big Spring branch, and the group of ditches which take out of the Big Spring branch in Oregon for diversion into Washington; the Little Walla Walla Spring branch through the Hoffman ditch; the East Little Walla Walla River, and the ditches which take from that river to conduct water into the state of Washington; and the West Little Walla Walla River and the group of ditches which take water from that stream in

Oregon and conduct the water into the state of Washington.

Below the point where the East Crockett, the Main or West Crockett, and the West Branch of the Crockett, rejoin to flow into the East Prong, the carrying capacity of the combined channel was about at its maximum on December 10th last winter, and the measured flow, measured by current meter, was about twenty-five cubic feet. per second.

The Ford branch, just above the point where it enters the valley of the West Prong, was measured on September 30, 1933, and showed a flow of approximately twenty-six cubic feet per second at that point,—that is not the entire capacity full bank flow.

The Crockett branch when it was measured had twenty-five second feet, and was full bank flow, and some slight amount was just oozing out of the top of the bank, so twenty-five second-feet is the approximate present capacity of the Crockett channel at a point after the three branches of that Crockett channel recombine. In other words, it is the maximum capacity at present of the Crockett channel entering the East Prong, while the maximum capacity of the Ford channel entering the West Prong is more than twenty-six second-feet, and is probably in the neighborhood of forty second-feet.

Measurements of the Walla Walla River in Washington were also conducted in order to determine the amount of the seepage gain of the Walla Walla river from the state line to the lower end of the project.

These measurements were made at different times during the summer of '32, and the data which we have

also permits computation of the seepage gain in the first four miles of the Walla Walla River channel in Washington for 1933, and in the total eighteen miles, approximately, of the Walla Walla River channel in Washington at five different times in 1932, showing the amount of seepage gain in that reach of the channel.

This survey was made by measuring all tributary flows that could be measured and all diversions, and by measuring the flow of the river itself at various points in that distance.

Then a computation by means of tributary flow, the subtraction of the diversion flow, indicates the non-visible flow into the river, which was called the seepage gain in that stretch of the river.

Now, with that rather detailed description of the river I can stop until another phase (339).

I will take up now the figures on the available supply of the Walla Walla River during the summer.

Stream gauge stations have been maintained on the Walla Walla River and its forks from time to time since about 1904 or 1903, by the United States Geological Survey in cooperation, I believe, with the state of Oregon, published in water supply papers of the United States Geological Survey, photostat copies of which are included in the hydrographic data, Exhibit No. 18.

So that the figures which I give here are taken directly from that data, and are merely my arrangement and computations on those figures.

Between 1903 or 1904, when measurements were started, as far as the records show, and 1917, the stations of which records were obtained were distributed at

various places along there, and it appears to me from studying the records that they cannot be used very well in connection with records since 1918 to indicate the flow of the river, because the stations were intermittent. The records are admitted in the descriptions written by the U. S. Geological Survey to be not always accurate or reliable,—gauges were washed out,—and I have therefore confined my computations to the period from 1918 on, that is, the last sixteen years on the river.

Moreover, the record for 1929 can not be used, because the Milton power plant was diverting water in that area past the gauge in amounts which are not known, since they were not accurately measured. Estimates were made, but the estimates are not shown in the U. S. G. S. water supply papers; and the year 1929, as far as I could determine, can not, therefore, be used.

It is my opinion that the sixteen years from 1918 until 1933 is such record as contains within its limits the variability of the river from its normal (flow). That is why I used those years, because they do show correctly the variability of the flow of the river in the summer months.

The stations which were used were not the same stations, however, all that time. From 1918 to 1928 the station was used which was about one-half mile below the confluence of the north and south forks, and was numbered I believe station 212, and will be referred to in that manner.

From 1930 to 1933 the stations which were used in this compliation are stations numbered 215 and 216.

Station 215 is on the South Fork about a mile above its mouth.

Station 216 is on the North Fork at the Road Bridge, about one-half mile above the mouth of the fork. These stations are, therefore, on a stretch of the river, so that measurements were made for eleven consecutive years just below the forks, and for the last four consecutive years just above the forks.

Now, the measurements from 1918 to 1928, therefore, can be averaged directly, I consider, with the records from 1930 to '33, particularly because a survey of the stream in that section in 1932 showed that the water which was diverted for irrigation between those two locations was very nearly equal to the return, that is, to the tributary flow, in that region, so nearly equal as to make it appear reasonable to average the eleven years of records at the lower station with the four years of records at the upper station, and that gives a total of fifteen years of records during the summer months, which indicate a very reliable average, particularly the variation of flow during that period.

Table 1, therefore, I will refer to at this time. This table shows the year, shows the station at which the records were obtained, and shows for each month of the summer, June, July, August and September, the mean flow in c. f. s., and the variation from the mean for that period.

This record shows that in general the years from 1918 to 1922, inclusive, and the year 1933 were years in which the flow of the minimum month of August was above the average for the 15-year period, while the years from 1923 to 1932, inclusive, showed a flow which was less than the average for the 15-year period. The year in

which the August—which is the minimum month— in which the August flow was the largest was 1922, when the flow was 132 c. f. s. The August flow was a minimum in 1931 with 75.7 c. f. s., a variation of approximately 56 second-feet from the highest flow shown in August, that is, the highest mean flow shown in August, to the lowest mean flow in August in that 15-year period.

The critical period in regard to irrigation water in this project, which is without storage, is the summer period of July and August and the first part of September.

The average for July over this 15-year period is 111.6 cubic feet per second, or otherwise known as second-feet—I refer to them indiscriminately.

The mean flow for August over the 15-year period is shown to be 100.2 c. f. s., and the mean flow for September during that period is shown to be 110.8 c. f. s.

These two stations, therefore, indicate the supply of irrigation water at that point and its fluctuation since 1918.

I might point out that the variation in flow in June, the fluctuation of flow in June, does not follow exactly the fluctuation of the flow in August. The things which affect that fluctuation are the amount of snowfall in the mountains and the rainfall during these months. That is, a heavy rain in September, for instance, 1927, in September, a month of heavy rainfall, brought the mean flow for that September up to 39 c. f. s. above the mean for the period, while all other Septembers since 1922 have shown less than the mean flow for the period.

I point that out to show the effect of precipitation during any one of these months on the flow.

During the earlier part of the summer the flow is affected by the snow conditions in the mountains, by the temperature conditions as to rapidity of melting, and by the rainfall occurring in any particular month in addition to the melting snow.

Coming back to June, therefore, the variation in the fluctuation for June is not just the same as for August. From 1918 to 1920, inclusive, the flow in June was below the average by considerable amounts. From 1921 to 1923, inclusive, the flow in June was above the average. From 1924 to 1926, inclusive, the flow in June was below the average for the period. In 1927 the flow in June was above the average for the period. From 1928 to 1931 the flow in June was below the average for the period. In 1932 and 1933 the flow in June was above the average for the period, and 1933 shows the greatest amount of these 15 years of records by which the flow in June exceeded the average. The flow in June, 1933, was 210 c. f. s. above the average of 231.5 c. f. s., a very heavy flow this past season in June, diminishing, however, rapidly through July to the August flow, which was only slightly above the mean for the period in August, and dropping then to September mean, which was below the mean for September for the period, showing that although there was a heavy flow in June, that flow diminished rapidly at the forks to less than average flow in September.

I will take up now the division of my work which deals with the administration and the use of irrigation water in Washington and Oregon during the low water period of 1933 (345).

After July 22nd, 1933, according to testimony by the Washington Water Master,—by the Walla Walla County Water Master,—Washington rights on the related stream system—which I will explain later what I mean by related stream system—Washington rights on the related stream system subsequent to 1892 had to be closed in order to make water available for prior rights on the related stream system. It appears that all prior rights were thus supplied, except that there was a shortage of water for the Gardena tracts, and some lands on the East Little Walla Walla above the mouth of the Big Spring Branch were also short of water in 1933 for part of the summer.

The period of closing of the rights subsequent to 1892 was from July 9th to 22nd. From July 9th until after the last of August may therefore be called the critical low water period.

The stream records which are available from our work in 1933 show the amounts of water which is flowing in various parts of the project in both Washington and Oregon and permit the computations of the gross duty of water in the two states.

First, the duty of water in Washington: Now, we refer here to Table 2. Now, the points of measurement of the available supply: We had the staff gauge on Mill Creek below Blue Creek during the period of minimum flow in 1933, and the records for Mill Creek below Blue Creek are taken from the statement of the flow in Mill Creek given in Hydrographic Data, Washington Exhibit Number 18. I have computed the flow at ten-day intervals after the period at which Washington rights subsequent to 1892 had to be closed, in order to show the

succession of flow conditions throughout the summer, throughout the critical low water periods after that time. The dates are, therefore, July 22nd, August 1st, August 11th, August 21st, and August 31st.

The flow of Mill Creek below Blue Creek is shown in Table 2, the data being derived directly from Hydrographic Data, Exhibit 18, with the exception of August 31st, which was assumed to be the same as the flow on the last date of record, about a week earlier. There was no precipitation in that time, and the flow was assumed to be continuous, as it had been practically continuous for a month before that time.

The first row of figures, therefore, shows the flow of Mill Creek below Blue Creek.

Another source of supply for the lands irrigated in Washington is the return from the City reservoir, which flow fluctuates greatly during the day and hence cannot be very efficiently used for irrigation. It can be used, but not very efficiently. The return from the City reservoir was computed by subtracting the city water consumption from the diversion at the City intake. The records of diversion and consumption are given in the Hydrographic Data.

The weir at the intake was checked during the first week in August by Mr. Douglas and myself under my direction and the head was established, so that we could know the discharge over the weir. The records were kept of that discharge and are given in the data.

This weir was not in at the period of July 22nd for the first computation, so that the flow at that time was assumed to be the same that it was on August 4th, when

the measurements at that point were started, 27 cubic feet per second.

That gives the second row of figures, then, the return from the City reservoir, which is added to the supply of water for the irrigated acreage, and all these flows are in mean cubic feet per second for that date.

Below the City is return from the sewage disposal plant, which runs very steadily, as shown in the data, at 5 cubic feet per second and is added to the supply of irrigation water available for Washington lands.

Now, around the fringe of the gravel delta in Washington are numerous springs which contribute water to the stream system. There are on a good many of those springs irrigated acreages with rights sufficient to take up all the water of those springs, with priority dates such that they do not have to be closed off to supply water to the other subsequent priorities on the,—to priorities on the lower Walla Walla River. Those springs I have excluded from the list of the springs contributing to the related stream system later in the report, but I have included all of them in this part of the report to show the available supply of those springs. The flow of those springs is shown in the Hydrographic Data.

The flow is measured at two different times. It was measured by Mr. Humphrey in August of 1932, and was measured also in October of 1933. Those are measured mostly by current meter.

The sum of the flow of the springs is shown in the data to be 14.02 c. f. s. in August, 1932, and 17.55 c. f. s. in October, 1933.

Now, 1933 was a somewhat wetter year than 1932. Moreover, the period in August is usually the minimum flow period, not only for the main Walla Walla River and Mill Creek, but also for the springs, which fluctuate in their flow very closely with the Walla Walla River and Mill Creek. For that reason I have interpolated between these flows approximately 17 c. f. s. in October, 1933, and 14 c. f. s. in August, 1932, to obtain the flow of these springs at the periods at which I made the computation for Table 2, and have assumed that on July 22nd and August 1st the flow of the springs, the combined flow of the springs, was 16 c. f. s., while on August 11th, 21st and 31st it was 15 c. f. s., the typical variation being the decrease through July into August.

Those figures cannot be far off, because there is not much fluctuation in the flow of those springs, and we have two periods, two different periods, of measurement.

The fifth source of irrigation water in Washington is the flow across the state line from Oregon into Washington.

The daily discharge records for 1933 are included in the Hydrographic Data, which show the total flow from Oregon into Washington across the state line at each of these dates, and by total flow across the state line I mean the flow in that part of the project which is included in the related stream system as far as the investigation of these irrigation rights is concerned. It does not include the flow on the western end of the alluvial fan in Oregon. We get, therefore, the total available supply of irrigation water in Washington at those five periods, after rights in Washington subsequent to 1892 had been closed. I sub-

tracted from that available supply the Gardena diversion, as indicated on those dates.

Now, the Gardena diversion figures given here are not exactly the diversion figures listed on the sheet entitled "Gardena Canal at intake" in Hydrographic Data, because some of the water which is turned down the Walla Walla River at that point is Gardena water which is turned down to lower users who by court decree have priority over Gardena, therefore, the Gardena diversion which is given here includes the number of cubic feet per second turned down the river which is actually Gardena water. That explains any discrepancy that may be noted between this Gardena diversion and the daily discharge records of the Gardena Canal. That gives, then, subtracting the Gardena diversion, gives the available supply for lands on the project in Washington which are irrigated by that supply. Part of my work has been to tabulate and compile the rights in the decrees of both states on the basis of priorities, on the basis of the stream systems, and in Oregon on the basis of the individual ditches. From that tabulation I have reached the figures given in Table 2 showing the acreages which are irrigated in Washington on each of the six main streams with rights prior to 1893. The total acreage is 4985.53 acres.

By order of court decree there are some acres which are irrigated on Mill Creek with rights subsequent to 1892. This acreage totals 472.93 acres.

The total acreage irrigated in Washington, therefore, by this supply of water is 5458.46 acres. This includes rights by decree prior to 1893, and also these rights which are irrigated subsequent to 1893 by court order, but does not include Gardena.

From that available supply and from that acreage irrigated by that available supply I compute an average duty of one second-foot to approximately 95 acres.

That is during the period from July 22nd to August 31st, inclusive. That is the average duty. It varies somewhat up and down, but it averages over that period of time that amount.

In that computation, I have taken this acreage on the theory that on July 22nd it was still all in crop and all requiring irrigation. These figures are based—the duty is based on the total rights; available water and land susceptible to irrigation under the decree.

I will take up next the Table 3, which shows 1933 water supply conditions on what I call Part 1 of the project in Oregon, for the same dates for which I have already computed the same thing in Washington. The particular method of administration in Oregon made it advisable, for the purposes of this tabulation, to divide the project into these two parts, which do not, by the way, include all the irrigated area in Oregon, but which are parts on which the duties of water could be reasonably computed from the data available.

They are typical areas, which cover most of the area irrigated by decree in the state of Oregon. I have made the same assumptions (regarding the available water and land susceptible to irrigation under the decrees and permits) that I made on the Washington side.

Part 1 of the project, therefore, I will take up first, in Oregon (352).

All of the water flowing in the North and South Forks of the Walla Walla River was during 1933 regu-

larly diverted and used for irrigation before reaching the centers of approximately sections 25, 26, 27 and 34, which are the outer edges of the gravel delta north and northwest of Freewater.

Therefore the available supply distributed over the acres which have rights by decree below that point to the upper fringe of the gravel delta was my general method of computing the duty of water from that point.

The records of flow in the south fork and north fork were taken at the gauging stations which have been maintained on those forks, the record of the south fork showing available supply above all irrigation was obtained at station 214, which is referred to sometimes as the U. S. G. S. station No. 214, which is above all irrigation of the south fork.

There is no station above all irrigation in the north fork, so we used the state cooperative station referred to here by letter "B" near the mouth of the north fork. Referred to on the map as letter "B". The combined flow at those two places represents the available water supply for points below.

I also, for the purpose of including all areas below the head of irrigation on both forks, made an estimate which I believe is reasonably accurate of the consumptive use of water on the north fork, and have included that estimated consumptive use of the north fork with the combined flows of those two stations to indicate the flow available for irrigation below the heads of irrigation of both forks.

The studies of the measurements which I have made in 1932 and 1933 indicate that this consumptive use in the north fork is approximately five c. f. s.

Measurements in 1932 showed a total diversion on the north fork on July 26, 1932, of 9.5 c. f. s.

And on August 25, 1933, showed 10.0 c. f. s. total diversion on the north fork.

There is, however, some gain in flow of the stream through return from that irrigation. Its amount can not be stated exactly, but I assume it was reasonable to take the flow of half of the total diversion as return flow,—and the figure is small in any case—so I used 5 c. f. s. for consumptive use in the north fork at the station 216.

The total flow from the three sources, south fork station 214, north fork 216, plus the estimated use in the north fork, gives the available water supply for part 1 of the project in Oregon as far as gauging station records can indicate.

The tabulation of rights in the Oregon decree indicate that the total acres by decree with rights prior to 1910, except the Hudson Bay Company, which does not divert water during its low water period, and Couse Creek, in which the flow is negligible, total 3140.051 acres.

Distributing the available supply over that computed acreage shows an average use of 1 c. f. s. to approximately twenty-six acres, and that is fairly steady through this low-water period.

It is my observation during 1933, as far as I could tell from a study of adjudication map of the state of Oregon and study of the decree, and general inspection on the ground, that during 1933 all rights by decree, that is, prior to 1910, obtained irrigation water.

If all of the rights by decree prior to 1910 did not obtain irrigation water, the duty of the remaining acres

was lower than 1 c. f. s. to twenty-six acres. If more rights obtained water from this supply, rights were being irrigated which were subsequent to 1909 when the decree was completed.

One right I should mention in this connection, the right of the city of Milton for the diversion of 7.24 c. f. s. which is not mentioned in this table. I have no figures of the amount of water which the city of Milton was diverting. I know the population of Milton by the last census, and as stated in the report of Mr. A. M. Piper, I believe, also, is less than two thousand population. I assume, therefore, that the return or the tributary flow of which there is some below the points of measurement of the gauging stations, a tributary flow which has been measured as in excess of four or five cubic feet per second a short distance above the Milton City water supply, and on the forks, would supply this city supply, and therefore would not need to appear in this tabulation. But if that return flow or gain or tributary flow does not directly enter the Milton supply, it compensates for it on lower rights.

The purpose of this tabulation is slightly different from a later tabulation in which I did use the same basis of computation in estimating the available supply in Washington in connection with the city of Walla Walla. This is for the purpose of showing available supply. The latter is for the purpose of showing possibilities of surplus.

In support of this computation of duty of water on this part 1 of the project in Oregon I will refer to table 4.

The records in table 4 of the stream flow are taken from hydrographic data, Exhibit 18. Table 4 shows the

total acres served on each of eighteen different diversions in Oregon obtained from my study of the Oregon decree, and study of the Oregon state adjudication map, and in cases in which I was in doubt, inspection in the field to ascertain where water was obtained.

I have also computed from the Oregon decree and the stated rate of maximum allowable diversion in Oregon as stated by the decree the diversion which those acres under each ditch are entitled to by the Oregon decree. I then used for each of July and August the mean flow in each of those ditches and the amount by which, if any, that flow was in excess of the maximum amount allowed for those acreages by the Oregon decree.

These results show that on 2587.266 acres out of the 3140.051 acres previously mentioned on part 1, which constitute the total acreage of part 1 by Oregon decree, the maximum allowable diversion by decree is 100.28 c. f. s.

The actual total diversion in these ditches in July as shown by a summation of the data given in the hydrographic data was 123.95 c. f. s., and in August was 113.07 c. f. s.

One ditch in July and three of the eighteen ditches in August were not carrying water in excess of the amounts allowed—the maximum amounts allowed by decree. All the rest of the ditches in July and August were carrying water in excess of the maximum amounts allowed by decree.

I may say, in regard to the points of measurements of these ditches, most of the records filed included in the hydrographic data are records kept by the state of Orego and agreed upon between the two states, and that

in the ditches which I personally supervised measurements in are also in the data. The measurements in the ditches were made as near as possible to the first turn-out from the ditch; they were not made directly at the river, because in some cases the ditches flow parallel to the river for considerable distances, and there is a possibility of direct return through the bank to the river; therefore I made the measurements as near as possible to the first turn-out from the ditch.

The figures shown here, therefore, are the amounts of water which are diverted for the lands with rights under each of these ditches.

The total amount of diversion of these eighteen ditches—the average diversion through July above the maximum amounts allowed these ditches by decree, was 25.20 c. f. s., and in August the average amount above the maximum amount allowed these ditches was 14.79 c. f. s.

Reduced to percentages the records show, therefore, in July 25.1 per cent, and in August 14.7 per cent more water being diverted for irrigation in this part of the valley than the maximum allowed by decree. And that was measured on eighty-two per cent, the ratio of the acreage under these ditches to the total acreage in that part of the project—eighty-two per cent of total area on that part of the project.

If the same amount of over-diversion pertains on the other eighteen per cent of the acreage irrigated on that part of the project by decree—or with rights by decree, the total diversion is found to amount to more than the combined flow at the gauge stations, which indicates clearly to me that there is gain in flow of the river below

the gauge stations, and that the gauge stations do not represent the entire available supply for irrigation.

Part of the ditches measured were in the canyon above noted; considerably the larger part of the acreage was from the Milton ditch down, however. Only about one-sixth of the total acreage was above the Milton ditch, five-sixths of the total acreage was below the Milton ditch.

There is somewhat more chance for gain in the river from direct return from irrigation above Milton than below Milton. Moreover, below Milton the diversions with the exception of the east side ditch, are all to the west from the Walla Walla River or Tum-a-lum, and therefore directs the water away from the eastern end of the alluvial fan from which the ground water flows out to supply rights in Washington.

I also studied a section of the project including 1143.77 acres on the so-called Spring branches just above the state line in Oregon. Points of measurement were established and maintained through the summer of 1933 which shows the flow in those spring branches at certain points below the gravel delta. The flow was also measured at the state line. So the difference in flow indicates the amount of water used in that section, approximately.

The points of measurement were on the Big Spring branch, on the Little Walla Walla or Ballou Spring branch, and the diversion from there, on the East Prong Spring branch and the diversion from there, and on the West Prong Spring branch, all measurements being below the heads of the Spring branches far enough down so that the chief seepage areas and springs were above the points of measurement; we could not include all the

water seeping into those springs; there is no way to measure it where you can determine the exact amount of water flowing in those springs.

There is probably some additional seepage below these points of measurement, because those are gaining streams below the points of measurement, so if there is any change in the available supply it is a gain due to seepage below the points of measurement, and if there is any variation from these figures it would be in the nature of an increase in water supply rather than less than shown here.

The total flow of the Spring branches is given; the flow at the state line is subtracted, showing the water used in that part of the project in Oregon from approximately the centers of sections 22, 23 and 24 to the state line.

I computed the acreages having rights by Oregon decree and also a permit right for two hundred and eighty-eight acres subsequent to the decree and which from appearances was irrigated in 1933, the total acreage is as previously stated, 1143.77 acres.

Distributing the available supply used on that acreage into those acreages shows a gross duty on that part of the project, varying as the season advances,—increasing, I should say,—increasing as the season advances, on July 22nd a duty of 1 c. f. s. to approximately sixty-three acres; on August 1 a duty of 1 c. f. s. to approximately seventy-one acres; on August 11th a duty of 1 c. f. s. to approximately seventy-six acres; on August 21st a duty of 1 c. f. s. to approximately eighty-two acres; on August 31st a duty of 1 c. f. s. to approximately eighty-eight acres.

The sources of the stream flow data are given in the hydrographic data.

That completes my survey of the actual use of water in 1933 based on the assumption that rights by the individual decrees of the two states were irrigated at that time, as brought out by the administration testimony, which has already been given in Washington, and on the assumption that all rights in the Oregon decree were irrigated.

The stream flow data which we have permits now a computation of what would happen if the Walla Walla river project, including Mill Creek, should be administered regardless of state line and rights closed off in their respective priorities on all streams in the related stream system, that is, on streams in which there is water to supply later rights. There are small streams through here in which the early rights take up all the flow, and those are what I call the non-related stream system. They are, however, the main streams which have water for later rights, or would have water for later rights—which I call the related stream system.

To show what would have been the effect, then, in 1933, in 1932 and in 1931, of such administration, regardless of state line on the number of acres which could have been irrigated, or which were irrigated in the two states, I made a computation of the surplus which would have resulted from closing all rights in Oregon subsequent to 1892 at the same time that such rights were closed in Washington.

The surplus thus obtained was distributed among the lands with subsequent rights in the two states on the

basis of priority and in accordance with the separate decrees.

Now, since the rate of use of water in Oregon affects not only the amount of the surplus but the extent of its distribution, I have made this computation on the basis of three different rates of use of water on the Oregon lands.

The first rate I have used is the maximum rate specified by decree, which in general is one and one-half miner's inches, or .0375 cubic feet per second per acre of land. The average,—I should point out in this connection the average duty allowed—the average maximum rate of use of water allowed by the Oregon decree is in excess of one and one-half miner's inches per acre, because of the provision in the decree that tracts of land over half an acre and less than one acre shall obtain one and one-half miner's inches of water, and tracts of land of half an acre or less shall obtain one inch—one miner's inch of water.

There is also a stock water right for 50 miner's inches of water which I have included, with no acreage corresponding to that right. For these reasons, the average maximum allowable use of water in Oregon by decree is somewhat in excess of one and one-half miner's inches per acre.

I use a miner's inch as one-fortieth of a second-foot. I have written into the record .025. The second rate for use of water in Oregon on which I based this tabulation is one and one-quarter miner's inches, which is .03125 c. f. s. per acre. This rate of use amounts to approximately one and seven-eighths acre feet per acre

per month, which if applied during the two months of July and August would amount to two-fifths of a seasonal total of about nine and one-half acre feet per acre.

I may point out in that connection that on the Sunnyside Project the indication is that two-fifths of the total seasonal supply is used in the two months of heaviest irrigation, which is why I have used two-fifths in that case.

The third rate of use in Oregon which I have used is one miner's inch, or .025 c. f. s. per acre, a rate of use which amounts to about one and one-half acre feet per acre per month, or a total depth of water of ten and one-half feet if used continuously at that rate through a seven-month season.

In this tabulation the rate of use of water in Washington was assumed to be one c. f. s. to one hundred acres, or four-tenths Oregon miner's inches per acre.

I refer now to Table 6, which shows for each of the three years 1933, 1932 and 1931 the amount and distribution of the surplus which would hypothetically have been created by closing Oregon rights subsequent to 1892, and shows the distribution of that surplus to Oregon and Washington lands with rights subsequent to 1892, as far as a surplus can be made to extend.

I have computed that surplus and distribution of surplus for each of the dates which were used in previous tables, representing the periods after Washington rights in 1933 were closed, July 22nd, August 1, August 11, August 21 and August 31.

The computation of available supply and surplus in Part 1 in Oregon was computed by combining the meas-

ured flows at gauging stations 214 and 216 and subtracting therefrom the requirements of the lands with rights to that flow prior to 1893 at each of the three rates of use before stated.

The same system was followed in Part 2 of the project in Oregon, and the total surplus shown is the combination of the surplus from Part 1 and the surplus from Part 2.

Now, the surplus thus computed does not represent, in my opinion, all of the surplus which would be obtained from Oregon by such closing of rights, because there are other sources of small amounts of water supply and there are other acreages which were not included and cannot be included with any accuracy in such a tabulation, but which would provide if closed off and which would augment the surplus here shown. These sources are rights on the North Fork, which were not included in this tabulation, springs and seepage return flow in the canyons above Milton and below the gauging stations used in the computation, springs and seepage return and gain on the four main spring branches in Part 2 between the points of measurement and the state line, from the upper reaches of these spring branches above the points of measurement, some additional surplus probably from the Lower Tum-a-lum, and probably also from Couse Creek.

There are six sources from which there would probably be some addition to the surplus which is here computed. The tributary flow from springs in the canyons above Milton were measured in 1932 at approximately a total of around four or five c. f. s. That much is

definitely additional. These other sources of supply would contribute further to the surplus.

There are, on the other hand, natural conveyance losses in the reach from the gauging stations to the state line. Since there is a considerable gain which is not represented in the surplus, and since, on the other hand, there are conveyance losses, it was considered fair and reasonable to assume that the gain in flow offset the conveyance losses in those reaches, and they were both, therefore, left out of the tabulation.

That explains, I believe, the computation of the available surplus (365).

Next, the distribution of that surplus among acreages which have rights subsequent to 1892: The amounts of the surplus are shown in the three pages of Table 6. From that surplus is subtracted, first, the Gardena shortage, because as conditions were in 1933 Gardena was somewhat short of water throughout this period and their priority would be filled first. The Gardena shortage was, therefore, subtracted to show the amount of water which would be available for distribution on other than Gardena lands in Oregon and Washington, and the figures given under the line "Remainder for Distribution" are the figures which are, therefore,—are the amounts of water which are, therefore, distributed among Washington and Oregon acres in this tabulation with rights subsequent to 1892.

The conditions, then, in 1933 were such that if the Walla Walla River project had been administered on the basis of the decrees of the two states, regardless of stipulation, and with the rate of use in Oregon on the

basis of the maximum allowed by decree, on July 22nd 614 acres in Washington would have been supplied with water which were actually in 1933 at that time closed off, and in Oregon 485 acres with rights subsequent to 1892 would have been supplied with water, and the remainder, of course, of the Oregon acres, if any, during 1933 which were obtaining water with rights subsequent to 1892 would have been deprived of water.

As to the reason for my assumption that the shortage of Gardena should be made up is that there was practically no shortage of other irrigators of equal priority in the State of Washington. A few acres on the East Prong later in the summer were short but the number was so few that I disregarded it. Gardena was practically the only shortage among the 1892 rights. On the Oregon side, I assumed the rights of Oregon continually flowing, of 1892. I did not compute any surplus as derived from Oregon rights of 1892. In other words, on both sides of the state line the only shortage among 1892 rights is Gardena. The surplus, therefore, created by closing off rights subsequent to 1892 would be applied, first, to the 1892 shortage, which was Gardena, then the excess after the Gardena right was filled would be this remainder for distribution, which would be ordinarily distributed and prorated among lands of both sides of the state line in their respective priorities and by those various rates in which the computation was made.

Now, a comparison of the time of the summer, first: The computation shows that in 1933 there would have been water available to irrigate additional acres in Washington with rights subsequent to 1892, and in

Oregon with rights subsequent to 1892, on July 22nd, August 1, August 11 and August 31, while on August 21 the Gardena shortage would have taken all of the available surplus. Through most of the summer, then, even on the basis of administration in Oregon at the maximum duty allowed by decree, there would have been some surplus available for distribution throughout the summer of 1933 besides to Gardena, except for a period during approximately the middle of August.

If the rate of use in Oregon were one and one-quarter miner's inches to the acre there could have been irrigated in Washington acreages with rights subsequent to 1892 totalling 1179 acres, in Oregon 950, on July 22nd, and there would have been water for acreages besides Gardena throughout the summer of 1933.

If the rate of use of water in Oregon had been one miner's inch per acre, all rights on both sides of the line from 1893 to 1903 except the Hudson Bay Company could have been filled from the surplus and there would have been approximately 7 c. f. s. left over for the Hudson Bay Company on their 1903 right, and there would have been a considerable surplus all the rest of the summer if that had been the rate of use in Oregon.

The minimum on August 21st would have showed 816 acres in Washington with rights subsequent to '92 which were not in 1933 irrigated. 816 acres would by this method of administration have obtained water, and in Oregon 599 acres with rights subsequent to 1892 would have obtained water.

I have computed, also, the same thing for 1932 on the three rates of use in Oregon, based on the three rates

of use in Oregon, and also for 1931. Those are typical years.

The flow of the Walla Walla River at the forks in August, 1931, was the lowest shown in the fifteen years of the records which we have.

The flow in 1933 in August was slightly above the average, and in 1932 was somewhat below the average. We therefore have a succession of years which show a variation of conditions from the very dry year of 1931 through a moderately dry year of 1932 to a fairly good year of 1933, showing the variations in the conditions.

In the driest year of 1931, when rights in Washington had been closed off in June, that is, rights subsequent to 1892 had been closed off in June, on July 1st, 1931, according to the records shown in Hydrographic Data for water supply conditions, there would have been a surplus remaining for distribution after the Gardena shortage was filled of 13 c. f. s., and that would have supplied 338 acres in Washington and 288 acres in Oregon.

After the first part of July there would not have been sufficient surplus in 1931 from Oregon to supply any rights outside of Gardena, and not nearly all of the Gardena shortage could have been filled that year, even though all rights in Oregon subsequent to 1892 were closed.

If the rate of use in Oregon had been one and one-quarter miner's inches more rights would have been supplied on July 1st on both sides of the line, but after that period no rights other than Gardena would have obtained water—no rights subsequent to 1892 I am talking about here entirely.

If the rate of use in Oregon had been one miner's inch per acre there could have been irrigated from the surplus on July 1st 1277 acres in Washington and 1086 acres in Oregon with rights subsequent to 1892, and on July 15th, also, there would have been a small surplus for distribution, but after approximately the middle of July there would have been no surplus in addition to that requirement to fill the Gardena shortage.

These three tables, therefore, show the effect of the varying water supply on the spread of water which could be created by administration, and they show the greatly increasing spread of water which would result by the administration of water in Oregon on the basis of a duty and rate of use more nearly corresponding with the rate of use of water in Washington.

Some measurements were made to determine the gain in flow on the Walla Walla river from the state line to the mouth of Pine Creek (371).

Several cooperative studies were made in 1932, and the stream flow records of 1933 permit the computation of return flow in the upper four miles, that is, in the four miles from the state line to the head of the Gardena canal. The computation shows that the gain in flow of the Walla Walla river from the state line to the Kennedy bridge, which is just below the Gardena intake, averages about five cubic feet per second during the period of low water flow, in August. The measurements for both years agree very closely on that figure.

The average for July in 1933 is indicated to be approximately eight c. f. s. gain in flow from the state line to the Kennedy Bridge. Below the Kennedy Bridge mea-

surements were not made in 1933, but measurements in 1932 indicate at low water period a return flow from the Kennedy bridge, which I will note on the map, to the mouth off Pine creek,—show a total return flow in August, 1932, of approximately two cubic feet per second in that reach, which is approximately thirteen or fourteen miles long.

The river is in a position there to be a natural gaining channel; it is entirely in Washington lands throughout that stretch—the gain is probably from both sides of the stream, and it may be irrigation along the banks or from further back, or it may be just the natural pick-up of the stream.

It appears, therefore, the total gain in flow of the Walla Walla River from the state line to the mouth of Pine Creek during the low water period does not exceed approximately seven or eight cubic feet per second.

There are a few items which occurred to me since (this morning) which will bear a further statement.

The character of the stream, the Walla Walla River, above Milton, is typical of the gaining stream. That gain is shown by the existence of many springs in the canyons above Milton. The extent to which these springs are augmented by the irrigation above can not be exactly stated. The Table 4, already submitted, showed heavy over-diversions in the canyon above Milton. It does not appear possible that all of the water thus diverted can be used by crops or evaporated. Some doubtless returns to the stream through the ground, but the water which returns can not reach the lower river as quickly as if it had been left in the stream.

It is very hard to tell what the lag would be; immediately adjacent where the ditch runs along the river bank, there probably would be a lag of maybe an hour or two in some cases; near the mouth of the south fork the land slopes away from the river and the ditches lead over from the river, which is on the west side of the valley to lands which are on the east side of the valley, and water thus diverted away from the river might be delayed several days, possibly longer.

If the water were applied during the flood season and long delayed that application might become beneficial, if there were excess waters during the flood season. It might augment the stream at the period of low flow. I was speaking particularly of the waters which are diverted during July and August, in the low water, at which time, of course, every second-foot which can be made available is needed down stream.

I wanted to point out once more something which I mentioned in the beginning, that during 1933 there was at no time at which I saw the streams any flow from the Crocketts or from the Ford branch into the head of the East Prong or the West Prong. The connections across the north edge of section 26—north part of sections 26 and 27 were dry at all times when I was there in July and August, 1933.

The points I am speaking of now are on the outer fringe of the gravel delta north of Freewater where during the winter season—fall, winter and spring—there is surface flow from the upper reaches across the delta and into the East and West Prongs, but where during the irrigation season of '33 there was no flow. Those are the points at which I stated the capacity of the Crockett

channel to be approximately twenty-five c. f. s. and of the Ford branch in excess of twenty-seven c. f. s.—twenty-six or twenty-seven.

The measurements given in Hydrographic Data, Exhibit No. 18, show the daily discharge records of Wells Ditch, which diverts water from the East Prong, Spring Branch, as shown on the map in the southeast quarter of the southwest quarter of section 14, township 6 north, range 35 east. The data I am referring to here is in Table 4-A (Washington Exhibit 30).

I have computed the acreage with rights on the Wells Ditch as shown by decree, and in cases of doubt as to whether they obtained water from the Wells Ditch I inspected in the field as closely as can be done and believe that I have very close to the acreage adjudicated water from the Wells Ditch. I find the total number of acres with rights prior to 1909 of 167.18, with a maximum allowable diversion at the rate specified by decree of 6.27 c. f. s.

The measurements show that from the 13th to the 31st of July, 1933, the average rate of diversion into the Wells Ditch was 6.96 c. f. s. measured at the intake—or an over-diversion above the maximum allowed by decree of .69 c. f. s.

The August average diversion was shown to be 5.78 c. f. s., which is less than the maximum allowed by decree.

Measurements are also available on the West Prong of the Little Walla Walla Spring Branch (378).

The weirs for measurement of the water supply in the West Prong are in the south half of the northeast quarter of section 22, township 6 north, range 35 east.

The difference in flow at that point and of the West Little Walla Walla group of streams crossing the state line, which includes West Little Walla Walla River itself and two ditches conducting water therefrom into the state of Washington, is assumed to be used on the acreage intervening between those two points of measurement.

From the land descriptions in the decree on the West Little Walla Walla River I computed the total acreage which derives water supply from the West Little Walla Walla River between those two points of measurement and from that and difference in flow of the stream at those two points I computed the amount of over-diversion, if any, from that stream. Including in the acreage all rights prior to 1909 on the West Prong, the total acreage is 375.74, according to my computation, with a maximum allowable diversion of 7.85 c. f. s.

There was found on the basis of this acreage that neither in July nor in August was there a use of water on the West Prong in excess of this maximum allowable diversion. However, in view of the fact that rights in Washington on the West Prong and on other parts of the stream system subsequent to 1892 were closed during most of July and all of August, I computed, also, the acreage on the West Prong which has rights prior to 1893, and on that basis, also, I computed the over-diversion.

According to my computations, there are 117.29 acres on the West Prong with rights prior to 1893, and their maximum allowable diversion as stated by the decree is 2.81 c. f. s.

The difference in flow of the West Prong from the weirs in section 22 to the state line during July was an average of 6.91 c. f. s., indicating that on the basis of closure of rights subsequent to 1892 there was an actual over-diversion on the West Prong of 4.10 c. f. s. during July.

The difference in flow of the weirs at section 22 and at the state line in August was an average of 4.66 c. f. s., indicating an over-diversion during August of 1.85 c. f. s. average flow.

I should like to call attention to Table 2-A (Washington Exhibit 30) which gives a list of the springs in the Walla Walla area in Washington which contribute to the related stream system and on which the tables stated this morning for tributary spring flow are based. This table shows the measurements made August 13th to 16th, 1932, and on October 3, 1933. I neglected to call attention to that table this morning.

In connection with Table 6, showing the available surplus—showing the surplus which would be available if the rights on both sides of the state line were administered without regard to state line and distribution of that surplus, I neglected to call attention this morning to the fact that I assigned to the diversion for the city of Milton for domestic and municipal purposes a flow at the present time of two cubic feet per second.

I recognize fully the fact that the decree awards Milton the right of 7.24 c. f. s. for domestic and municipal purposes. However, with their present population of less than two thousand, and the fact that for domestic and municipal purposes does not include extensive use

for irrigation, and in view of the rather well-known figures on domestic water consumption of many cities, I assume that two second-feet is a liberal allowance for the city of Milton at the present time, which is the time at which I am basing my computation to show what available surplus could be obtained.

Two cubic feet per second for a population of less than two thousand is a supply of above eight hundred gallons per capita per day, which is far in excess of average supplies to municipalities in the United States.

Let me point out in the same connection that the Walla Walla city consumption as shown by the ratio of city use given in hydrographic data, Exhibit 18, relation of the Walla Walla city consumption to their population, is considerably less than the ratio I have allowed for Milton.

In connection also with Table 6, I wish to point out that I computed the Gardena shortage on the basis of the present administered area of Gardena of 5,631.33 acres.

The related stream system in Washington, as it has been called, consists of streams which are administered by the water master to supply rights of 1892 and prior by closing off all rights subsequent to 1892 except those rights on which there is a special court decree.

The related stream system thus administered consists of:

First, Mill Creek, including Blue Creek, College-Boyer Creek, Coyle Spring Branch, Lower Cold Creek, Titus Creek.

Second, Garrison Creek, including Bryant Creek and some small springs.

Yellowhawk, including Caldwell Creek, Lasater Spring Branch, Shelton Spring Branch, Stubblefield Spring Branch, Whitney Spring Branches, and certain small springs.

Mill Creek is 1, Garrison is 2, Yellowhawk, 3.

4 is East Little Walla Walla River, including Big Spring Branch.

5, West Little Walla Walla River, including Walsh Creek.

And 6, Walla Walla River, including Blue Mountain Spring Branch, McEvoy Spring Branch.

That is all the points I have. I will put them on the map at the recess.

There are pretty nearly three hundred wells in the Milton-Freewater vicinity indicated by small circles or dots on the map (Washington Exhibit 17). A survey was made jointly by the engineers of the two states in September, 1932, to locate and obtain measurements of flow and size of pumping equipment and size and depth of wells, and the records of the kilowatt hour consumption of power used in the wells indicates that during 1932 a total of nine thousand and ten acre-feet were pumped during the irrigation season in the Milton-Freewater area. I refer to hydrographic data, page 230 (Washington Exhibit 18).

NOTE—The testimony regarding wells was submitted subject to the objection of the State of Oregon (382).

We have had landowners testify here (for the State of Washington) concerning the injury to their lands

through shortage of water. I will take up the streams on which these several lands are located and (will state) what the supply of water for the aggregate rights on each of these streams was in accordance with their priorities if administered in the same manner as set out in my testimony this morning, based on the stream supply that I have found from examining the hydrographic data, starting with the East Little Walla Walla and Big Spring Branch.

My computation of the surplus which would have been available in 1933 on the basis I outlined this morning shows that 1893 rights on the East Little Walla Walla River total twelve acres, and that those rights would have been supplied with water if the rate of water in irrigation had been the maximum allowed by decree, those rights, twelve acres on the East Little Walla Walla River in 1893 would have had water on July 22nd, on August 1st, and a very small pro rata part on August 31st.

In 1932 that acreage would have been supplied with water for about ten or fifteen days after it was actually closed, according to the testimony of the Walla Walla County Water Master.

In 1931, that acreage would have had water for a short time after they were closed—after the rights in that year were closed, but after the first part of July they would not have had water the rest of the summer. That is on the basis of the use of water in Oregon at the maximum rate allowed by decree.

If the use of water in Oregon in 1933 had been on the basis of one and one-quarter miner's inches per

acre, 1893 rights such as these on the East Prong mentioned would have been supplied with water throughout the summer, instead of being closed off after about the middle of July.

In 1932, on the same basis of one and a quarter inches to the acre in Oregon, those rights would have had water through at least the first part of August.

In 1931, on that same basis those rights would have had water only through into the first part of July.

On the basis of one miner's inch per acre in Oregon those rights would have had water in 1933 through the entire summer.

On the basis of one miner's inch per acre in Oregon those rights would have had water throughout the summer of 1932.

On the basis of one miner's inch per acre in Oregon those rights would have had water through to about the middle of July, 1931.

The West Little Walla Walla River: 1893 rights on the West Little Walla Walla River total 43 acres. With an administration in Oregon at the maximum rate allowed by decree these lands would have obtained water through to about the 10th of August and after the last part of August in 1933 (385).

On the same basis in Oregon, in 1932 they would have obtained water to about the first of August.

On the same basis in Oregon they would have obtained water to shortly after the first of July, 1931.

On the basis of one and one-quarter miner's inches per acre in Oregon 1893 rights on the West Little Walla

Walla River would have obtained water throughout the summer of 1933.

They would have obtained water through to about the first of August, 1932, and to shortly after the first of July, 1931.

On the basis of one miner's inch per acre in Oregon those rights would have obtained water throughout the summer of 1933, throughout the summer of 1932, and to about the middle of July, 1931.

In computing the allotment of water for rights on the West Little Walla Walla in Oregon, I used the special decree (adjudicating those rights). I used the general decree for the rest of the stream system. Where I refer to the three rates in use in Oregon, I used the general decree and made no variation for West Little Walla Walla, because their rate of use is considerably less than that in the general decree.

On Garrison Creek there are 25.75 acres with 1900 rights. On the basis of the maximum rate allowed by decree in Oregon, in 1933, 1900 rights would have acquired no water.

In 1932, 1900 rights would have acquired no water.

In 1931, 1900 rights would have acquired no water.

On the basis of one and a quarter miner's inches per acre in Oregon about 80 per cent of the 1900 rights would have had water,—that is, there would have been water to pro rate on the basis of about 80 per cent of the 1900 rights participating up until the last part of July. After that they would be cut off.

In 1932, 1900 rights,—in 1932—about one-sixth of the acreage in Washington having rights would have par-

ticipated in the surplus down to about the 22nd of July; that is, on that date one-sixth of the rights would still have been participating in a small surplus. After that date they would have been without water.

In 1931, 1900 rights would have been deprived of water throughout the season.

On the basis of one miner's inch per acre in Oregon 1900 rights would have been supplied with their full allotment of water to about the 10th of August. They would then have been dry for a period and in the last part of August would have again been supplied to about two-thirds of their full amount.

In 1932, 1900 rights would have been supplied to their full amount to about the first or shortly after the first of August.

In 1931, 1900 rights would have been supplied to about the middle of July.

The 1895 rights on Yellowhawk total 208 acres. On the basis of maximum rate of use allowed by Oregon decree there would have been about three-fourths of a full supply for the 1895 rights in 1933 through to the last part of July, with no water available after that.

In 1932, at the same rate in Oregon, about one-fourth of the 1895 rights could have been filled until about the last week in July.

In 1931, 1895 rights would have been deprived of water throughout the summer.

In 1933, at one and one-quarter miner's inches per acre in Oregon, 1895 rights would have been supplied with water until about the 10th of August and for a short period about the middle of August would have been with-

out water, and again in the last of August would have received water up to about three-quarters of their full allotment.

For 1932, at one and a quarter miner's inches per acre in Oregon, 1895 rights would have received their full allotment until about the last of July, and about two-thirds of their full allotment for a few days after that, about the first of August.

In 1931, 1895 rights would have been supplied with water only until about the first week in July, after which they would have been deprived.

On the basis of one miner's inch per acre in Oregon, 1895 rights would have been supplied with their full allotment of water throughout the summer in 1933.

On the same basis in Oregon, 1895 rights would have received their full allotment until about the first week in August and would have received a little water toward the end of August.

In 1931 on the basis of 1 miner's inch in Oregon, 1895 rights would have received water only through the first—approximately the first week in July.

Lower Cold Creek is a tributary of Mill Creek and is, therefore, listed under Mill Creek in the compilation which I have made. I do not have a separate tabulation for lower Mill Creek and lower Cold Creek. The same statement would refer to all '95 rights in regard to water supplies to that vicinity (391).

In making my studies of the Walla Walla River, I have not made them entirely from an engineering standpoint. In such a study it is impossible to differentiate between engineering and agriculture and common sense.

As to my experience in agriculture, I worked on a farm once in 1913. I was in college at that time. I have never had charge of the distribution of water in any part of the country. I have never had any experience in the irrigation of lands. I, myself, have done no irrigating. I spent four days on this project accompanying Dr. Powers in soil reconnaisance which he made. I have made a good deal of study of soils in the last 3 or 4 years. The system of distribution that would distribute the water in the manner I have explained takes into account the available water supply and its disposal. In making my calculations, I have considered that that water supply would be the resulting surplus from such administration. The water supply was taken as measured at a point just above Milton. As to a consideration of any interferences with the distribution, physical formations in the country this side of Milton, I made the statement that in my opinion the gains which are not indicated in the surplus would approximately offset the losses which might occur in the stream system. As to whether I considered in my calculations that this water supply was available at all points, subject only to the deductions of diversions for irrigation, I have in mind that it was a continuous water supply which if not interfered with would flow on down to the state line. I would not say that in my calculations I have assumed that all interferences have been removed. What I did was to remove certain interferences which interrupt the supply at present and assumd if those interferences were removed the water would flow on down to the state line.

In my examination of the stream above the forks, I estimated that the canyon of the south fork runs from

50 to 100 yards wide, a little more than that at the mouth, possibly ⅜ of a mile wide. The sides appear to be basalt formation. All the water that comes within that canyon on the south fork must necessarily drain towards or into the river. That same condition exists on the north fork. From the forks of the stream down to the City of Milton, the canyon, being somewhat wider, is also bounded on its sides by basaltic formation, and necessarily the drainage in that part of the basin is to the stream. Below the City of Milton and to the east of the Tum-a-lum there are hills that extend from Milton clear past the state line. There is much less irrigated land on the east side compared to the irrigated land to the west of the Tum-a-lum. From the beginning, the large amount of irrigation has been to the west of the Tum-a-lum. The development of the country to the west necessarily required the diversion of water away from the stream. The physical formation of the country below Milton does not make the drainage in that part of the country away from the stream towards the west. For a distance of from a few hundred feet at Freewater, increasing maybe a half mile or possibly even a mile at a point opposite the McCoy Bridge, the drainage is towards the stream. In that territory from one hundred yards wide to half a mile or possibly a mile wide, the McCoy Spring Branch rises on the old McCoy place and flows maybe 100 yards until it enters the stream from the east side. Any spring rising on the west of the stream flows in a northerly and northwesterly direction, more northerly than westerly in the related territory. None of them enters the stream until the main stream turns in a westerly course. There are spring branches

north of McCoy Bridge which enter the main stream on its northerly course before it reaches the state line. The spring branches flow in general in that reach of the stream from the Nursery Bridge to the state line; what spring branches there are, both to the east and to the west, flow northerly parallel to the stream, and some spring branches flow in before it reaches the state line, and others don't join until after the stream has turned to the west.

The first spring that rises west of the stream just north of the McCoy Bridge is what we call the Hodgin Spring Branch, which flows parallel to the main stream for a distance of over three-quarters of a mile and enters the stream at the south edge of section 13-6-35, before the Walla Walla River reaches the state line. The other springs farther to the west as shown on that map and rising in the spring territory in sections 23 and 24, township 6 north, range 35, I should say flow in a northerly direction. Grandview Creek runs in a generally northwesterly direction. The trend of the Big Spring Branch is north bearing to the west.

In Table I (Washington Exhibit 30), I have taken the mean measurement for the month in the years 1918 to 1933. The station at which the records were taken is 212 located about a half mile below the north and south fork. I will mark it "212" on the map (Washington Exhibit 17). The station hasn't been there for several years. I will also mark Station B here as "216," Station B-1 as "215" and Station 214—the map isn't clear and I can't say within a quarter of a section where it is but it is above all irrigation on the south fork, so I

will mark it just above A-1. In taking that mean, I used the regional water supply papers from which those photostats (in Washington Exhibit 18) were made.

On page 44 of Exhibit 18 there is a table given for the year 1926. In Table I, Washington Exhibit 30, for July I took the mean as 80.6. On the 11th, 13th, 18th and 24th, the supply is below the average. That would essentially make no difference in the distribution, because that is an unusually steady stream in the low water period. It is rather unusual to have a stream so steady as the Walla Walla River is in any particular month in the low water period. There is a maximum variation in July of 1926 from 93 at the beginning of the month, it drops through the first week to about 82, from there on the maximum is 84, and the minimum is 72, and in my experience it is an unusually steady flow for that time of year (403).

My calculations of distribution (Tables VI, VIa and VIb) were not based on (the year) 1926. They were based on the actual flow on the 22nd of July and on the first of August and on the other dates in 1933, 1931 and 1932. They were not based on the mean flow at all. They were based on the actual flow on those dates.

In the future where the variation in years is as marked as this stream, my analysis certainly would apply, because I have used three typical years of varying water flow. 1931 was a year of minimum flow in August, 1932 was a year of slightly less than the average flow, 1933 was a year of slightly greater than average flow, so we have three examples of the years, each of which was different, and any other year succeeding would prob-

ably be similar, very similar, to one of those three years. If it is not similar it would be on the side, probably, of much greater rather than less.

I have no way of telling whether or not in the future the stream flow would be as it has in the past 3 years, except that the indication is that within the memory of man, the life of most men, the stream regimen does not change.

The only times that I have been upon that stream has been during the past 2 years. I noticed some pretty fast fluctuations in June following two heavy rains we had, about the 20th of June and the 28th of June. When it rains a lot in the hills, when the snow melts fast, the stream comes in rather rapidly. It is not torrential in nature in low water flow. When there is cause for fluctuation, it fluctuates quite fast and when the stream starts to diminish in flow, it diminishes very rapidly. Whether that diminution will occur within the period of a week, depends on how much diminution you mean, that is, it will—as soon as the rain stops in June, for instance, your heavy rains in the middle of June following melted snows in the mountains, the stream in 1933 raised to a flow of over six hundred cubic feet per second; then it started to drop, and by the 1st of July was down to—taking the two forks together, because I have not computed—at stations 214 and 216 the combined flow the 1st of June was 622.

On the 15th of June, 514.

Then it dropped to 300 on the 20th.

It dropped to 205 on the 1st day of July.

To 148 on the 10th day of July.

To 124 on the 20th day of July.

To 118 on the 31st day of July.

So there is a gradual drop, starting as soon as the June rains stop.

In June, 1933, the combined flow at stations 214 and 216 dropped from 646 c. f. s. on the 10th to 300 c. f. s. on the 20th, a drop of 346 second-feet in ten days, about 35 c. f. s. a day on the average. As to whether with those kind of drops and fluctuations in the stream the regulation of distribution from it is very difficult, nobody can use 600 c. f. s. of water up there anyway; so that has to flow on down through. After it drops, then the regulation can begin. After that it is not difficult.

I did not use the mean (flow) as a basis of distribution; I used it only to show fluctuation over the period of the sixteen years, fluctuation of average water supply over that period of time; for no other purpose did I use the mean flow of the Walla Walla River. I used those figures to show the flow that would normally be expected to occur in any particular month in the summer season. I did not apply the mean to my duty datum. I used the flow on the particular five days; I used the mean for the day; there are some slight fluctuations during the day—but the mean for the day is indicated by the recorder—the graph, and that is corrected and stated in the tables which are published. I did not calculate the mean for the month to determine whether or not the flow at that particular time was above or below normal. There are not serious enough fluctuations, according to my observation, during the days of the low water flow, to affect seriously, except as it is artificially fluctuated,—

for instance, by the Walla Walla city return, a fluctuation which is greater at night than in the daytime, would affect such irrigation. But natural fluctuation of the stream during the low water period aside from unusual rainfall would not affect the administration of that stream.

I am assuming here that there was not any such a fluctuation occurring upon that particular day. Whether the distribution of water on a particular day must be based on the minimum flow on that day depends on whether you have much fluctuation. If you have considerable fluctuation, you might have to base it on that minimum flow. In a territory the size of the Milton district, it takes some time for the water master to get over the whole district. With a steady stream flow it would never be necessary to employ enough men to regulate the ditches every day (410).

I made a study of the seepage losses along the stream in the Tum-a-lum section and on the Crocketts. We have data from which a theoretical analysis of seepage losses above Milton could be made, but it did not seem to me to be reliable enough to base any such computation on. Our observation is there are gains in the stream from the nature of the stream which I pointed out—the canyon slopes to the stream—that the stream above Milton is a gaining stream. I do not believe there is any appreciable seepage loss from the stream above Milton.

Below Milton along the Tum-a-lum, the stream bed is filled with boulders and gravel. At the Milton Nursery bridge, the Tum-a-lum is about 150 feet wide. It widens out below that. At the widest section below, between that

and the McCoy bridge, if you include the whole stream wash it is about a quarter of a mile wide, I would estimate; I never measured it. I should judge it is about a quarter of a mile wide, including the whole stream wash. The actual channels of the stream are not that wide, by any means.

At one point there, there are two or three channels where the water has evidently flowed at high water. There are evidences of one of the stream channels at that point I am thinking of—there are two or three channels, in all of which water flows at high water—but it is difficult to distinguish which could be called the main stream channel at that point. There is interchange. There is filling of one channel with boulders, and scouring out at other places, so there is constant change in that section, as on any stream in any section.

There are weeds growing through there, there are banks of soil, weeds growing in the channel. I tried to dig down into the rock, and found the rock was wedged in with a sandy, silty soil; I could hardly dig it out with my fingers.

The bed of that stream in the section between the Nursery Bridge and the McCoy Bridge, facilitates loss by seepage more than in the canyon above Milton.

I have a computation here which I made of the seepage loss in the Crockett branches. These measurements were made during the Fall of 1933 as shown in the hydrographic data. We measured the flow in the Crockett branches at the Frog, by means of the weirs. The weirs which measure the flow in the Crocketts are in the northeast quarter of the northeast quarter of section 2, town-

ship 5 north, range 35 east. We measured the flow at the Crocketts at the Frog both East and West Crockett branches. The diversions were measured,—or if they could not be measured—if there were no measuring appliances or no good section for a meter, they were estimated and reasonably closely estimated—the flow in the Crocketts at the edge of the gravel delta one-quarter of a mile north of the center of section 26, and at the center lines—east and west center line one-tenth of a mile west of the center of section 26—were measured, and from that data the loss in the Crocketts was computed.

We found that when we used a mean flow at two different periods—our tests were made during the fall—there was some fluctuation in the stream during that time—but we found that a week, a seven-day period was available in which the flow was fairly steady and gave a good indication of the mean flow. We found a five-day period succeeding that in which the flow was fairly steady and gave a good indication of the mean flow.

So that these are mean flows during those two periods of time.

We found that when 27.0 c. f. s. started down the Crocketts at the Frog, approximately 4.7 c. f. s. was lost before reaching the center of section 26. That is a loss of seventeen per cent. The total distance of channels is about six miles. The direct length from the Ford to the lower point is about two miles, but there are three different channels through most of the reach through which that water can flow for the later period.

When a flow of 44.3 c. f. s. started down the Crocketts at the Frog we found a loss of 6.8 c. f. s., or approximately fifteen per cent.

In my distribution of available water, account was taken of this seepage. We assumed the gain in flow which I pointed out is visible at certain places to a certain amount approximately offset the seepage loss. We have some data here, and we have measurements showing amounts of spring flow in the canyon. There is more than that. That does not represent the entire gain. It is not included in the water supply. There is more gain from other parts of the system which I pointed out.

There is no gain in the Crockett. In calculating my distribution it was necessary to assume that the water from the Ford and Crockett would be available in the main stream or water in the main stream would be available in the Ford and Crockett as the occasion would require. The Ford branch would be considered to supply water to the main stream through the (West) Little Walla Walla River. In the summer of 1933, the Ford Branch, at all times which I was past the place where it would supply water to the West Little Walla Walla, was dry.

In a system of distribution where the water could be switched from one place to the other, I made no calculations as to what would be the transportation loss of making such changes. Ordinarily that would be the position on the gravel delta where the major part of whatever transportation loss there is would be with the current (416).

I have measurements taken of the water that was flowing in the Tum-a-lum at the time it was turned down this fall. The gauge from which our stream records for two years at the Milton Nursery Bridge were obtained

was read on the 3rd day of November, when the water first, I believe, was observed to go through the main stream. I do not know how long in point of time it took the water, after it left the Nursey Bridge, to get down to the McCoy Bridge. I do not have that information. Our gauge at the McCoy Bridge was washed out at that time and was not available.

I think that possibly the state line record during the fall of 1933 might show what the flow was at the state line on the 3rd of November. I can tell you. At the Milton Nursery Bridge on the 2nd of November, 1933, the flow was 25 c. f. s.; on the 3rd it was 240 c. f. s. At the state line on the 2nd it was 8.8 c. f. s.; on the 3rd it was 160 c. f. s. In other words, the mass of the effect of the flow had already been felt at the state line within a day after the time it was felt at the Nursery Bridge. Not all of the flow had showed up yet, but the mass of it, the bulk of it, had showed up within a day. An increase at the Nursery Bridge of 215; an increase at the state line of 151. A loss of 64 c. f. s. Sixty-four second-feet on the basis of 240 would indicate a 25% loss but there is always some lag in the stream system, which would account for part of that loss. The rest of the water would come on later.

(425) We made the seepage loss measurements on the Crockett in the last part of November and in the first part of December, 1933. There was some diversion for irrigation on the Crockett at that time. The locations (of the diversion) are shown in the Hydrographic Data, and if not shown by location they were grouped together and estimated as miscellaneous diversions. That was included in the tabulation from which I com-

puted the losses in the Crockett. I believe you do not have the copy of that tabulation. That is just from notes of my own that I gave that data. Those diversions were measured whenever possible, but sometimes it was not possible; it was so small an amount, one-tenth or two-tenths of a second-foot, not possible to measure it, and it could be estimated with reasonable accuracy. Part of the diversions, which I have used in the computation, are included under miscellaneous estimated diversions in Washington Exhibit 19. Most of the diversion dams in the stream were not out at that time; in general conditions were rather similar to conditions as they had been the previous summer. There are not dams, there are dividing weirs and barricades at points across the stream—that is, planks or bulkheads for the purpose of dividing water between ditches, and some of them are weirs for the purpose of measuring. Allowance for the backing up of the water by boards in the dividing boxes which force water out into the ditches would be included in the measurements.

The quantities of water as shown measured in the main streams were measured at the head end and at the lower end. At the head end they were measured on the weirs which had been used all summer for measurement on the Crockett; on the low end there were no weirs and they were measured with current meter, with several measurements made and with discharge rating curves drawn, and the daily discharge records taken from the curves, as shown in the Hydrographic Data.

It was the measurements for two periods, one period of about seven days from the end of November to about the first week of December, and the second period of

about five days, about the 10th of December, both in the same year.

I think possibly evaporation loss, which is very slight, might be more in July and August than in November and December. The seepage loss would not be greater in case they put in boards to back up the water and throw more out upon the land, because there is no essential difference in such a condition between the way things were when these measurements were made and the way things are during the irrigation season.

It would not require the addition of more boards in the diversion points to throw out more water upon the land; it would require merely the removal of the farmers' diversion bulkheads. In fact I might state that the streams at that time of year (November and December) have more water in them than they have during the summer season. In most of the courses there is no water in the lower parts of the streams during the summer, therefore, the seepage losses measured at such a time as we measured them would be greater than during the summer.

The flow in the stream itself would be as free and unimpeded in December as it is in July. As the stream flow is lower in July, there are some slight adjustments which are made in the lengths of the control weirs across the stream during the irrigation season (429).

At every time I visited the Tum-a-lum during July and August, the entire distance between the Nursery Bridge and the McCoy Bridge has not been dry. At times there is water flowing from the Nursery Bridge for several hundred yards below the Nursery Bridge, and usually there has been water for some distance above the

McCoy Bridge. That would leave a distance of approximately a half mile that would be dry between those two bridges.

Mr. Humphrey and I were on the Tum-a-lum at one time in the summer of 1932 making measurements on return flow studies. We used the Nursery Bridge and the state line as measuring points. There was a space through there in which there was no flow of the river.

With this flow in 1933 of 19, 21 and 25 c. f. s. for 3 days, the state line had shown a slight rise, but it had affected the flow at the state highway, which is another mile or two below the state line. Not by reason of springs rising, but by reason of return flow in the channel of the stream itself, because as far as I know, from my observation, there are no springs in that reach—that is no visible side channel springs in that region between the state line and the state highway. The first large noticeable increase was on the 3rd of November, when 240 c. f. s. was put in—that came down with a flood to that amount of water.

I have tabulated discharge measurements at the state line, which I think is accurate enough for the purpose of this approximation here. The state line measurement I have (Washington Exhibit 47) on the 29th of October (1933) was 8; 30th, 8; 31st, 9; November 1st, 8; 2nd, 9 and the 3rd, 160 c. f. s.

In my Table III (Washington Exhibit 30), I used as the number of acres irrigated in Oregon with priorities up to and including 1909, as 3140.051 acres. That came from a lengthy tabulation of the rights listed in the Oregon decree by ditches, and by main stream systems, from the compilation of a card catalog system by which those

rights could be arranged in order of priorities, as they are not arranged in the decree, by the addition of the acreages with rights for each year cumulatively to that date, and by subtracting from the total acreage thus given the acreages with rights on Couse Creek and the Hudson Bay Company right. As to whether I consulted Stipulation No. 3 with regard to areas under irrigation under each priority, I am not sure what Stipulation No. 3 is. I consulted what I understood was the stipulated tabulation of the Oregon and Washington rights for a check on my work. Assuming that the stipulation shows 4363.34 acres in place of 3140.51 acres, it would materially change my estimated use of water. Such a large change as that would of course change the result.

In calculating the distribution of water, the theory which I have advanced is based entirely upon one water supply—that from Oregon coming down. The water supply on lower Mill Creek (for instance) would be relieved under this system of distribution, if surplus was available for lands on the Walla Walla River below the mouth of Mill Creek from other sources than Mill Creek, rights on lower Mill Creek would not have to be closed off to supply those lower priorities. I took no cognizance (in my calculations) of the renting of water (436).

All of my figures with regard to springs for the Washington area are based entirely upon the measurements of August 13 and 16, 1932, and October 3, 1933. The only way in which the flow of the springs in Washington came in (my calculations) was to determine whether acreages irrigated from those spring branches would be benefited by additional water from Oregon. If there was enough water in those spring branches ap-

parently from those two measurements of those spring branches so that the water would run to the lower river if rights in those spring branches were closed off, then those rights on those spring branches would be benefited by additional water from Oregon. If, however, there was not sufficient water in those spring branches as indicated by those two measurements to supply all the prior rights of those spring branches, then subsequent rights on those spring branches would not be benefited, and I so considered it.

I considered those springs as sources of supply for Washington. I used that calculation for the three years, but the flow of the springs enters only in a minor way.

To relieve the situation, we will say, on lower Mill Creek, I would transport the water through natural channels—part of it down the Tum-a-lum. I considered how much water would have to be turned loose at the Nursery Bridge in order to reach the lower rights upon the Walla Walla, in the amount that would show up eventually. Twenty-two second feet would go through eventually. As to how much water would have to be turned in at the Nursery Bridge in July of any year, I couldn't say, because in July there was none turned in there and we couldn't measure it. In June, 1932, when I and Mr. Humphrey were making a study there 20 c. f. s. did not get through (but) there was flow at the state line continually. The water that was turned down at the Nursery Bridge did not get over the dry spot as a surface flow; it might have gone under it. The stream from the McCoy Bridge down is a gaining stream; that is true whether water is going over the spillway at the Nursery Bridge or not (440).

You can get a pretty good indication of the loss there would be from the amount that was turned down there in June, 1932, from the figures. There is difficulty in making figures of that which are accurate, first, that there is no time of the year that I have observed when there was a steady flow at the Nursery Bridge down the Tum-a-lum for a long enough time to get accurate measurements; the flow is either dropping rapidly or it is rising rapidly, and that is not a condition which is conducive to good hydraulic measurements to see definitely what happens.

In June, July and August the stream between the Nursery Bridge and the McCoy Bridge is not naturally a falling stream, it has already fallen. There is no water there. To attempt to get 22 c. f. s. down the Tum-a-lum during June, July and August would to some extent be wasteful and to the extent of the waste would not be economical. It would not be as economical as a really good irrigation canal.

The channel of the Ford Branch below the northeast quarter of the southeast quarter of section 22-6-35 and in section 15 has all the appearances of being a natural channel. The channel of the Crockett north of (the place) where the branches come together in the northeast quarter of section 26-6-35 has the appearance of being a natural channel. In the upper channels of these streams, on the delta, there's considerable evidence of artificial change. Up in there is where I made my study of seepage. The measurements in Table IV (Washington Exhibit 30) were made at the weirs where they branch out of the Frog. In estimating the amount of water to be distributed, I measured the over-diversion

at these weirs and not down at the point where the farmer diverts from the stream. The seepage between the weir at the measuring point and the farmer's diversion point would decrease the amount of over-diversion.

In making a distribution of water on priorities irrespective of the state line, part of the surplus would necessarily have to come down the Crockett. That is due to rights on the Little Walla Walla River in Oregon between its intake and the Frog, which requires at least, as I remember, about 55 or 56 c. f. s. to pass the Peacock Mill, which has a non-consumptive use right. That water can go only to the Frog from the Peacock Mill; there is no channel by which it can return to the Walla Walla River or Tum-a-lum; it must, therefore, go to the Frog, and be distributed from the Frog. If the rights of the lands to which water is distributed from the Frog were administered in that manner, there would be some water remaining in the Crocketts to come down to Washington through the East and West Prongs. The Ford Branch would also supply the West Prong (447).

The indications, as far as I can gather from the data I have, is that most of that water entering the upper end of the Tum-a-lum at the Nursery Bridge would show up in the stream channel by the time the state highway bridge in Washington is reached. There may be some loss in that reach which enters the underground reservoir, but it does not show gravity outlets in the Big Spring Branch, in the spring branches along the Tum-a-lum, and possibly further to the west, in the East Prong.

The McCoy Bridge to the Nursery Bridge is about 2 miles. The Frog is about a quarter of a mile directly

west of the Nursery Bridge. .The distance from the Frog to the McCoy Bridge would be (the length of) the hypotenuse of a triangle which has a quarter of a mile base and a two mile altitude.

There is always a difference in a dry section when the stream is a rising stream from that when the stream is a receding stream. When the stream is a dropping stream, points down the stream always show a greater flow ordinarily than points up stream; while if a stream is a rising stream, downstream points will ordinarily show a less flow than points upstream. That is what makes measurements under such conditions very difficult of analysis (449).

My theory of distribution (while) irrespective of state lines was not also irrespective of natural conditions—not any more than the existing stream system up there is irrespective of natural conditions. In the development of the ideal, it is sometimes necessary to make a great many adjustments and variations because of natural conditions and sometimes it is not, depending on the simplicity of the computations or their complexity. I did not assume a perfectly ideal condition. I assumed conditions as approximating about what they are at present. I took the Oregon present practice as one basis of distribution and assumed the practices which are different from what they are at present using for comparison. My theory of distribution would not compel an entire change of the present Oregon method of distribution. It would involve some change and improvement. Of course, with rights subsequent to 1892, particularly considerably subsequent to 1892, it would involve a rad-

ical change; on rights prior to 1893 it would not involve a radical change, although it might involve some change. I do not think it would compel a complete lining of the conduit through which the water would be conducted to get it down to the lower Walla Walla without loss—without *any* loss, yes, but without reasonable loss, no. I have not computed it without loss. I have assumed, as stated before, that the gains in stream flow which were not considered here, offset the losses throughout the system. For that assumption, we have measurements which we have brought out that we have measured the springs in canyons which total 4 or 5 c. f. s. at least, and other sources of gains which are not shown in the surplus. There are those sources of loss which have been stated to be in the Crocketts, the figures being given yesterday, which are not excessive losses in the neighborhood of 4 to 6 c. f. s.; then in the Tum-a-lum a certain unknown amount which may be slightly greater, but according to all indications is not an excessive loss.

Whether I, as an engineer, would recommend the construction of such a project, based upon the amount of information I have, was not a requirement. If I were starting out with no irrigation in this valley, I would redesign the system entirely at the start, because it has just grown. I would have started measurements made and continued them for as long as it was possible to continue them. Whether I, as an engineer, would recommend the investment of large sums of money based only upon the information upon which I have based my theory here, such facts as I have shown, I believe would warrant certain changes (453).

At this place Washington Exhibit 30 containing Tables I, II, IIa, III, IV, IVa, V, VI, VIa, VIb and VII were introduced in evidence as part of the testimony of James G. Woodburn.

The witness resumed (1179-1190):

(1180) In order to make clear the record in regard to the losses and gains which I used in the computation of my Table VI (Washington Exhibit 30), I will state that I used actually a net excess of losses over gains of approximately 7 c. f. s., which is contrary, possibly, to the impression I left (in my testimony) in which I said that the losses approximately were offset by the gains.

I have the schedule which I was given at the Pacific Power and Light Company office as the schedule under which the rates during the years 1932 and 1933 were computed. This (schedule) is published Tariff 59, Public Service Commission of Oregon No. 17, effective February 28, 1933. This schedule also, I should state, in regard to date, was the same as was in effect in the summer of 1932.

The net rate charged consumers for power is at the rate of 6 cents per kilowatt hour for the first 50 kilowatt hours used per month per horse power of maximum demand.

The next fifty kilowatt hours used per month per horse power of maximum demand are charged for at the rate of one and one-half cents per kilowatt hour.

Excess monthly consumption over the above is charged for at the rate of ¾ cents per kilowatt hour.

There is a minimum monthly charge of a dollar and a half per month per horse power maximum demand.

There are quantity discounts which apply only after the monthly bill reaches a hundred dollars. Most of the irrigating plants which I investigated have bills considerably under $100, and, therefore, are not affected by the quantity discounts.

This plan of charge for electric power, it seems to me, to have some effect on the amount of electricity used for pumping. The reason for its having an effect is that there is a certain minimum charge under which very little or no water might be pumped, and after the usual minimum water requirements are met for the lands excess amounts of water can be pumped at the low power rate of ¾ cents per kilowatt hour, so that it is often cheaper to use excessive amounts of water rather than to pay for labor to manipulate lesser amounts more efficiently.

I have computed a hypothetical case in which I have computed the power consumption and the monthly bill for a ten-acre place irrigated by a 3 horse power motor operating a pump of an over-all efficiency of 60 per cent under a 40-foot head. This is a typical plant and corresponds closely to a large number of plants for pumping irrigation water in the Milton-Freewater area.

I find by that computation that to pump a depth of six inches of water in a month over the ten acres would require 342 kilowatt hours, a 3 horse power motor would have to operate the pump 21 per cent of the time, and the power bill would be $11.57.

If 12 inches depth were obtained over the ten acres, the power consumption would be doubled, that is, 684 kilowatt hours, the pump would have to run 41 per cent

of the time, and the bill would be $14.13, an increase of only $2.56.

If 18 inches depth of water were obtained over the entire 10-acre tract, the power consumption would be 1026 kilowatt hours, the pump would have to run 62 per cent of the time, and the bill would be $16.70, again an increase of $2.57.

If 24 inches depth of water were obtained over the 10-acre tract in one month, the power consumption would be 1368 kilowatt hours, the pump would have to run 82 per cent of the time, the bill would be $19.26, again an increase of $2.56.

If this farmer wished to use water more efficiently by installing a 5 horse power motor and the larger pump so as to irrigate for shorter periods with larger flows, other conditions being the same, he would be penalized in power costs, as shown below.

To obtain six inches of water over the 10-acre tract, the power consumption would be 342 kilowatt hours, the pump would have to run 12 per cent of the time, and the monthly bill would be $16.38.

For 12 inches depth of water, the power consumption would be 684 kilowatt hours, the pump would have to run 25 per cent of the time, and the bill would be $20.13, an increase of $3.75.

To obtain 18 inches depth of water, the power consumption would be 1026 kilowatt hours, the pump would have to run 37 per cent of the time, the bill would be $22.70, an increase of $2.57.

To obtain 24 inches depth of water, the power consumption would be 1368 kilowatt hours, the pump would

have to run 49 per cent of the time, the bill would be $25.26, again an increase of $2.56.

Thus it is seen that a six-inch depth of water provided by a 5 horse power pumping plant costs nearly as much as 18 inches depth with a 3 horse power plant. The result is that places of 10 acres or less are operated usually with 3 horse power or 2 horse power pumping plants, and in many cases they run these plants continuously throughout the summer (1185).

As to my opinion as to what is the loss of water in the Tum-a-lum section from the Nursery Bridge to the Washington state line, I will state that under the conditions of steady flow, which occur very seldom throughout the year in that stretch, the measurements which we have, as given in Hydrographic Data, Exhibit No. 18, indicate that during the period from the 18th of November, 1933 to the 5th of December, 1933, inclusive, was a period of fairly steady flow at the Milton Nursery Bridge, at the state line, and at the State Highway Bridge, about two miles below the state line. The average flow during that time at the Nursery Bridge was approximately 20 cubic feet per second. The average flow during that time at the state line was approximately 15 cubic feet per second. The average flow at the state highway during that time was approximately 18½ cubic feet per second.

In that stretch of the river there is one tributary named Hardesty Creek which may get its water from the east side of the valley, far enough away from the Tum-a-lum section so that it cannot be called a part of the Tum-a-lum channel. That, in my opinion, is the only tributary in that reach which is not essentially a part of the stream

channel itself. Hardesty Creek during that period was fairly steady at about two cubic feet per second.

That gives a very strong indication, therefore, and is the most reliable data that we have and indicates that the losses in the Tum-a-lum from the Nursery Bridge to the state line do not exceed seven cubic feet per second at that flow, while from the Nursery Bridge to the state line the losses do not exceed 3½ cubic feet per second.

The distance from the Nursery Bridge to the state line is about four miles, and from the Nursery Bridge to the State Highway Bridge is between five and six miles.

Those tabulations (Washington Exhibit 47) which I have prepared are taken from the Hydrographic Data except for the averages and summaries, which are my conclusions from the Hydrographic Data.

In my measurements here, the time that the stream bed is dry between the Nursery Bridge and the McCoy Bridge is shown by no measurements being taken. The measurements under the columns headed "Opposite Dugger Place" and "Below McCoy Bridge" were not started until November 27th, 1933. The fact that there are no figures merely means that the measurements were not taken. I believe that prior to November 3rd, 1933, there was a dry stretch there below the Nursery Bridge down to within a short distance of the McCoy Bridge. I was not there at that time to inspect it. On the other sheet (Washington Exhibit 47) the amounts shown beginning with the 25th of June, would indicate that the stream bed was turned approximately dry below the Nursery Bridge. There was, as shown here, a trickle there. I made no tests of the loss from the Nursery Bridge down to within a mile of the McCoy Bridge only

as shown here. The Dugger place, I might explain, is about a mile below the Nursery Bridge—opposite Dugger place, about a mile north of the Nursery Bridge. That is in the fall of 1933, measurements were made at that point. That there are no measurements opposite the Dugger place up to the 27th of November wouldn't indicate that there was no water flowing in there up until that time although earlier in the fall I am sure there was no water flowing at that place. By earlier in the fall I did not mean that the channel was dry at all times. It was not. There was a period in there starting with the 3rd of November, in which there was water, considerable amounts of water, flowing, but in general previous to the first of November the channel at that point was dry.

At this place Washington Exhibit 47, being the compilations of Dr. Woodburn, was admitted in evidence for the purpose of illustrating his testimony and showing his computations (1189).

CARL A. LARSON, for the State of Washington, testified in part (896-912, 1174-1177):

I reside at Prosser, Washington. I am with the U. S. Department of Agriculture, Bureau of Plant Industry, Division of Western Irrigation and Agriculture, holding the position as agent cooperating with the Irrigation Branch Employment Station at Prosser, Washington. I have been carrying on this work at Prosser since 1931. I have the degrees of B. S. in General Agriculture, and of M. S. in the Department of Soils, from the State College of Washington. I also have a Doctor's degree from the same institution.

The work at Prosser consists of irrigation experiments on various crops, on irrigation plots, on orchards

and alfalfa, corn, wheat and potatoes. The other work consists of work with salt soils, salt concentration of irrigation waters, and general farm work, distributing water, at the 200 acre station. Prosser is in the Yakima Valley, 30 miles northwest of Kennewick and about 87 miles northwest of here (Walla Walla). The Yakima River is a tributary entering the Columbia River near Pasco.

I have made a study of the water requirements for lands in the Walla Walla River basin. I accompanied Mr. (F. O.) Youngs on a few occasions at the time he made his soil survey. He finished the soil survey for the lands in Oregon in 1932. A similar survey was made of the lands on the Washington side. That was completed last year (1933). I am acquainted with the basis of the soil classifications which Mr. Youngs used in preparing this map, Washington Exhibit 15. Mr. Youngs classified the various soils into groups that had similar characteristics in regard to irrigability. The slope of the land was considered, the texture of the water table, and the salinity. To determine these characteristics, Mr. Youngs used methods that are commonly practiced by government soil surveyors, as using a speedometer that was graduated in hundredths of a mile for distances, and using a plane table with a compass for his directions, and using a ruler on his map which was an inch to the mile graduated in fiftieths of a mile, and following the roads and crossing through sections on forties, where there were no roads, while with the aid of the compass distance was paced off until coming to another road where he could also check his distance by section lines. The method of investigation, of course, included the questioning of farmers on whose farms he would happen to cross, looking into wells,

see the profiles, ditch banks and road cuts and any other excavation that was available to show the profile of the soil.

I couldn't say whether he examined the county records and other data that might aid him in arriving at his conclusions. I found the map (Washington Exhibit 15) very helpful in determining water requirements. The soils were grouped in similar types that had similar characteristics and these groupings were shown on the map in different colors. The soil characteristics which determine what particular class the type of soil takes are the steepness of the slope, the water table and the texture of the soil.

The color key on the map (may be) explained. The areas colored in green are the No. 1 soil, not very steep, smooth to unrelated, of good texture, a deep soil, and of good water-holding capacity. The 1-R are the rich soils, which are of a good texture, well drained, and some of them are irrigated considerably, especially in the western part of the area. 1-R-A, which goes with that, is 1-R soil and upland soil on the bench, but the A was added to that to show that the land was not nearly as steep and laid very well for irrigation. 1-R-A is designated upon the map by a little lighter green than the No. 1 (soil). Another large section that is very prominent is No. 3, which is designated by this rather orange color.

The sections up here on Mill Creek, southwest of the City of Walla Walla, there are a few patches of this No. 3, but the big sections are above Mill Creek and down here in this large delta above Freewater (902).

2-A is of a small quantity and very scattered. The largest acreage in any one place is shown on here next to the hill on this side, and a few small spots on the forks in the river above Milton, and also against this hill to the west of Freewater. The 2-A soil is shallower than the number 1. The gravel will be found from a foot and a half to four feet,—that does not mean that the gravel is free from soil. 2-A is designated by the yellow color.

2-B is a much shallower soil and approaches more nearly to the 3 type. The covering of the soil is from six inches to a foot and a half, and underneath that the soil is somewhat similar to this 3 type.

The difference between 3 and 2-B is the fact that there is a fairly clean soil covering, usually. That is designated by the—it is almost as yellow as the 2-A here.

2-B is also in small patches and is usually found around the edges of this gravel bar, this fan. You see the small patches of 2-B on the edge, and also mingled in (the region along) the river southeast of Milton. The 2-B generally borders the 3 soil. The distinction between the 2-B and the 3 is that the 2-B has a fairly clean soil covering. 1-D is the land that is salt, the water table is usually within 6 feet, but the salt concentration on 1-D is not sufficient generally to harm that growth; that is designated on the map by the purple; there is a considerable amount of that all along the river, salt land.

4 is similar to 1-D in regard to water table. It differs in that the salt concentration is usually strong enough to be injurious to plant life, and also calcified or lime hardpan located in some of those areas.

And 5 is—very little of the No. 5, which is similar to 4 in salt concentration, but it is on higher ground and does not at the present time have a water table. No. 5 is mostly down in this section around Lowden and Touchet, and is designated (on the map) in a dark brown color.

No. 6 is the non-agricultural land, the river-wash, and steep slopes that can not be cultivated. There is much of it along here and along here and along the Walla Walla River, where the river wash is predominant.

The investigational methods employed to determine my conclusion as to the water requirements of these various soils, included a survey of these various types, looking at the soils, supplementing the texture observations with soil samples after an irrigation to get a good estimate of the amount of water the soils held after they were irrigated, compensating for the time for those soils to drain, and determination of the weight of a cubic foot of soil on the representative types, in order to have a basis for making an estimate of the acreage that would be held in the different foot levels of the soil.

I went to a number of farms with a set of questions which, as I asked the questions, I looked over the farms, as the questions were answered, to get information in regard to irrigation practice and the cultural methods used. This was late in the fall, and I depended a good deal on the farmers' statements for the crops that they produced. In a few cases, such as alfalfa,—the hay was there, and could be judged—the production of it—but the apples had all been moved off—most of the fruit had been moved off. I took into account the soil conditions and the typical types. In determining the field capacity, of course, the texture of the soil has a great deal to do with that,

supplemented by moisture determinations made on representative pieces, and the weight of the soil.

A very good, close estimate was made of how many acre-inches were required to fill that soil to the third foot. Soil samples taken after an irrigation or a sufficient rain to supply as much water as would be put on by an irrigation to fill that soil gives a very close estimate of the field capacity, if the soil has had an opportunity to drain—sufficient time after the irrigation to drain (906).

I determined the basis for the time element from the number of samples taken at the Irrigation Branch Experiment Station at Prosser. I got a very good idea of how long it would take the soil to drain out the moisture. Soil samples were taken in the first and second foot of depth and the soil survey of the various groups designated quite closely the depth of the soils. The samples consisted of 200 four hundred grams. There was not particularly any difference in the size of samples for different types of soil. Those samples were taken to get a profile of the depth at which I wished to take it. I did not necessarily use a larger quantity of soil in determining the requirements for the gravel type. The profile depended on how heavy a section of the profile that I took. I don't think there was any difference—remarkable difference between those. Most of the water deliveries were made on the constant flow basis except that a group of farmers were rotating. There is no storage water for irrigation involved in this territory that I know of. In determining the water requirements, I took into account the type of water delivery the farmers were using. The majority of the irrigation in this territory is corrugation—furrow irrigation. The length of furrows varies a

great deal; sometimes this is determined by the lay of the land; other times the furrows are just too long for efficient irrigation in some of the soil types—the length of furrows—some of the longest down on the 1-R group soils near Lowden, close to a quarter of a mile, from that on they dwindle down to very few feet, according to the lay of the land. The width between the furrows was, in the gravelly soils, some instances the furrows were only put by the tree rows, leaving fifteen to eighteen feet, approximately, between the furrows. For farm land, such as the alfalfa, the furrows were put three and a half or four feet.

With a small amount of water, irrigating an orchard, for instance, the furrows would have to be rather close to the plant roots, so the roots would only be wet. If more of the soil was wet up, the corrugations would have to be put closer together. For closely grown crops, such as the row crops, the corrugations would have to be put closer, the more the soil would be wetter. The length of time the water was allowed to run in the rills I found varied a good deal according to cultural practice. Some of the long rows, the water was allowed to run as much as sixty hours. And then on the gravelly soils the length of run was considerably shorter—four to six or twelve hours.

The length of the furrows, as I said, ranged according to the lay of the land, a distance range of from a quarter of a mile down to a few feet.

The distribution systems examined showed that there were very little irrigation works, usually just irrigation out of earthen ditches, with no structural turn-outs on to

the corrugations, but just filling the ditch up and not overflow, into the furrows (909).

And in the Gardena section there was more flume encountered than any other place on the project, and irrigation works consisted of spiles used in the banks, a large number of spiles used to divert the water out of the supply ditch into the corrugations. I did not find water-saving appliances in general over the valley. The water penetration varied a great deal according to the cultural practice, the growth, and somewhat in crops. The crops were divided into orchard, truck crops, and alfalfa, quite generally; some sections the orchards probably being about fifty per cent of the crops grown. That is quite true in the gravel bar above Freewater, that the orchards were approximately fifty per cent of the acreage, I believe. I did not find many farms of one crop production. Most of them were diversified.

For the purpose of determining water requirements, I think a large number of these soil classifications shown on the map (Washington Exhibit 15) should be grouped. I would suggest a group of 1, 1-R, 1-D, 1-RA, 4, 5 and 2-A. In the second group I would put 2-B and 3. The water requirements for the first group, which I will term Group A for the purpose of my testimony, I set at 4.8 acre feet and on a constant flow basis of about a half miner's-inch per acre. I am speaking of gross duty—the diversion at the stream. The water requirement I should allot to Group B, that includes types 3 and 2-B, is one miner's-inch to the acre. That is gross duty. That amounts to 9.68 acre feet on a basis of 6½ months season. The distribution of 9.68 acre feet for Group B is ratable by the month. It gives a gross of 18 acre-inches per

month. That requirement was set as it was to take care of the peak month. The other months, the earlier months and perhaps the later months, would not be nearly as much, but on a constant flow basis, in order to get the water for the peak month, the high amount was set. I considered that to be sufficient for any peak month. If they take the water in April, May and part of June, it would be an over-delivery. That soil in the sand district which is labelled Class 3 will store very little water from one part of the season over to the other. In arriving at that amount I did not consider any of the use records for any particular pieces of land. With limitations, the use which has been made of water is the important factor in determining the duty. Whether the duty of water should be fixed at an amount somewhere near what the farmers use in actual practice, depends on what you term reasonable efficiency in applying water. In setting the duty of water I don't see how you can disregard either the maximum production per unit of water or the maximum production per unit of land. Where a farm is being operated by a large amount of water, which gives him a maximum production of crop per acre but the average production per acre foot of water used is low, I would want to know how he was irrigating before I would reduce his water. Assuming that he was irrigating in a reasonably careful manner, without any excessive waste, cultivating his corrugation so that the water will be sure to go in, and (yet) he didn't have enough water, then it would be reasonable to give him more water. If he was not using efficient methods, he should not have more water. As to whether it has heretofore been the custom in a great many instances, in projects throughout the nation, to try to

spread out the water over too much land, my experience does not cover (the) great number of projects you speak of. From my reading of material on this question, a number of projects were started without any soil survey and it was found that the soil was so shallow in a good many cases that it could not profitably be farmed. The cutting out of those particular parts would not necessarily increase the amount of water that would be available for the other parts of the project. I have in mind the Sunnyside Project, which I am quite familiar with.

In considering the duty of water, I studied the depth of the gravel soil on the No. 3 lands in and about Freewater and Milton. In no place did I encounter hard-pan. In regard to the texture of soil, the heavy soil seemed to carry down pretty well through the first foot; after that it became quite coarse. In no case of wells have I found virtually a clean gravel formation below. I did not find a cement gravel strata. My investigation did not take me down to the cement gravel. In some of the wells that I examined, I found them curbed down for a distance of 8 to 20 feet. I took no tests of the soil below the first three feet. I made no study of the soil below the first three feet. The texture of the soil below the first three feet where it becomes coarse has a great deal to do with the vertical drainage. The vertical drainage is a very material determining factor in fixing the head of water necessary to get over a tract of land and irrigate it, after considering the surface. After considering the surface, the same is true, in fixing the number of irrigations that is required during the growing season. The profiles that were shown, the texture carrying down the coarse sand and gravel mixed with the rocks, gives a good estimate

of the loss of water from vertical drainage without having studied the soil formation below the third foot. By profiles I am referring to some of the wells that were opened and from the discussion of this type of soil with the soil surveyor. I did not see any of these profiles in the wells that were curbed. If my recollection is right, there was a well that was open below the curbing on the gravel fan, No. 3 land, up on Mill Creek and there was a well above Freewater, too, that was open below the curbing. The other information on that was also derived from talking with men who had dug wells. I derived my knowledge of the soil conditions below the three feet from the conditions set forth. There are so many of the wells curbed up, I assumed that curbing was necessary from the top of the ground to the place below the loose gravel formation, or they wouldn't go to that expense. In fixing the duty of water, the expense which the irrigator has gone to, is a matter for consideration. Providing the irrigator has used every efficient method that he could and then didn't have sufficient (gravity) water, if he has gone to the expense of putting in a pumping plant, it would be powerful evidence that his gravity supply was too small. The expense that the irrigator goes to, to augment his water supply during years of low prices, makes it a matter of greater consideration (919).

I have not carried on any irrigation work upon lands of the same character as the No. 3 soil. My work has been distributing water upon the experiment station farm, near Prosser. From my experience there (at Prosser), I would consider that the economical length of (irrigation) furrow in the distribution of water upon No. 3 lands here, should not be more than 200 feet. In my ex-

amination of the lands on the gravelly soil, I measured several of the furrows (there) with the speedometer; they were right around 600 feet. That would be approximately a 36-rod run. They were located in the northwest quarter of the southwest quarter of section 26, township 6 north, (range) 35; that would be right at the north end of the gravel belt, as indicated on the map. In the classification of soil there (on the map) the northwest quarter starts with No. 3 and drops to 2-B and then to 1. That run was all on No. 3 land. I do not know whose land that was on. There were a large number (of furrows) on the gravel belt, No. 3 land, 20 rods in length. If in the development and progress of irrigation in the community, the irrigation practice had brought into use furrows 20 rods in length, or substantially that, and had found such use economical I would say that the furrows should be longer than 200 feet (but) with limited water, in order to use that efficiently, without putting additional irrigation works in, the rows should be shortened.

In considering the duty of water, I took a number of those yields per acre from questioning the farmer. We have statements that the farmer considered his yield reduced by reason of the shortage of water such as that in No. 3 land on Mill Creek. I do not recall that any one I interviewed on the No. 3 land near Milton and Freewater made that statement. If the cutting of the supply of water, on a farm well cultivated and in a high state of production, using 20-rod furrows, injured the crop, that would not necessarily be proof that the duty of water was too high. If he had shortened the rows after that experience and cultivated his furrows so they would not break over, and perhaps took some precautions with ir-

rigation works in his ditch, I would say then there would be an opportunity to lower the duty. I wouldn't say that the theories on irrigation practice and the use of water, must necessarily yield to actual practice. As far as irrigation efficiency goes, you should, it seems to me, expect a reasonable amount of efficiency in comparison to another district. In other districts I have not had any experience with the particular classes of soils I have around Milton and Freewater. In my experience I don't believe I know of any soil which is just like it. Generally it seems to be unusually fertile and productive for that class of soil (923).

In making my soil tests I did not test for the moisture equivalent to the soil. I did not make any test to determine the wilting point. As to the correction in my moisture test for gravel and stones in the soil, I took a profile of the gravel soils; naturally (I would) have to discard some of the larger rocks, but I think it was a fair example of the profile. In order to get rid of those large rocks you necessarily had to break your formation—you couldn't have it in the natural formation in your test. The profile would naturally crumble when you took it, anyway. Those rocks in the soil run down to as fine as sand, up as large as niggerheads. As to the size of a niggerhead; its a niggerhead—6 or 7 inches in diameter would about strike it. From that down to a couple of millimeters in diameter for what we call gravel. In my classification of soils, I do not make any distinguishing classification between the soils that contain different sizes of stone, to test for moisture. I was mainly interested in what the foot level would hold, and tried to get a representative profile for that.

I found the longest (irrigation) furrows near Lowden. The soil was classed as 1-R. It is possible to get the water to the end (of the furrow) with running it a long time. It was common in those long furrows (quarter of a mile) to run the water 60 hours. I wouldn't say that the crop production on the irrigated lands near Lowden is very low generally. A lot of the bottom land near Lowden is No. 4 which is saline, at least. Parts of this land are used as pasture; in order to keep the salt from concentrating on the surface and killing what little pasture grass there is, this salt concentration must be diluted. It cannot be done by drainage except through washing, and where the drainage is not provided, you can only wash it to the water table. I think that it would be considered as an economical and beneficial use of water to take water from the Class 3 land up by Milton and Freewater and turn it down for this salt grass land by Lowden, just as (the Lowden lands) are now, without any drainage, provided they can grow pasture on it to pasture livestock, if the use of water is excessive in any one place and it can be used beneficially on another. Seems to me, the balance between the two economically, how much the pasture is worth, if any can be grown, and the value of the other; considering also that if the above farmers on the gravel used efficient methods of irrigation and still were short of water, why, it should not be taken from the high producing areas to put on the lesser area. That is my opinion. A large number of the pasture lands in that area were (irrigated) by flooding. I did not determine the concentration of black alkali down there (927).

To determine the efficiency of the irrigation practice

up on No. 3 lands by Milton and Freewater, I selected and visited twelve places that I considered quite representative of the area. I did not visit the Warren Reeder, Alta Rogers, or Elba Rogers places. I was not informed as to the places test runs had been made on by the State of Oregon. Talking with the farmers and seeing some of the rows running is the only thing I would have to judge by as to the head of water required to get over No. 3 land. My conclusion as to that is not based upon any actual present knowledge of my own except by comparison. In making my test I estimated that to fill the majority of the root zone, say the first 3 feet, upon the No. 3 area, it would require about 4 acre-inches. In determining that factor, I considered the soil beneath the 3-foot depth, very low in holding capacity. The porosity, the coarseness should increase the vertical drainage. As to the percentage of loss by vertical drainage, in the first place, I did not calculate to have enough (water) on to lose a great deal—just what would hold. The 4 acre-inch application would just give about what the soil for the first 3 feet would hold without any vertical drainage, provided all the available moisture was exhausted in that 3 foot depth. In actual farming, very few of the farmers would be that exact. That is compensated a good deal because all the available moisture is not exhausted. They put on a little bit less at one time and a little bit more at another time. I wouldn't say it was impossible in actually applying the water to the field to approach the exact measurement of 4 acre-inches. On my experimental plots at Prosser, a third of an acre, I am able to use field methods of irrigating and apply that amount of water. That is fine, sandy loam. It would be considered as

Class 1. I believe that the farmer could reach a higher stage of efficiency, some of them, on the gravel than they are (reaching) now, with not a great deal of expense. Under the conditions delineated, I do not think it would be impossible. In my test, I did not take samples in the interval between irrigations. I did not make tests to determine how long No. 3 soil will hold usable water after an irrigation, only judging from the irrigation interval. Under my experiments, the water content of the No. 3 soil would have to be restored (in) about eight to ten days. If a crop has a tendency to temporary wilting, it should be irrigated. If a tree begins to wilt, it is not necessarily a sign that you have waited too long before applying irrigation; it may mean that the last irrigation was not efficient. If the water did not penetrate when you irrigated, it was also not sufficient. In the irrigation of some crops, it is necessary to maintain the moisture content of the soil at a reasonable point above wilting point in order to get the best production. In no case have I found that the (fruit) trees were damaged unless the water in the major portion of the root zone got down to the wilting point. Temporary wilting may affect the quality of the fruit. I didn't take moisture samples to determine what percentage of the water applied at the edge of the plot can be accounted for by samples of the moisture stored. There is very little difference, in most cases, because the rather large head of water that is put on pushes the water through the furrow and then is cut down to cut out the waste water, so that there is about an hour's difference at the head over that which is at the bottom. The trees of these orchards near the headgate may have been more vigorous and larger than

(those) down at the lower end of the furrow. I didn't take particular notice of that, however. Assuming that as a fact, it would not necessarily indicate a greater water supply for the (more vigorous) trees. I have in mind an orchard over on Mill Creek where the trees look just as good at the foot of the orchard as they do at the head. There is no water table there. This is on No. 3 type and very seldom is there a water table there that I noticed. If the water table stands higher and closer to the surface in some of the No. 3 soils, I haven't noticed it, and I haven't heard about it. I found no such case on the No. 3 lands (near) Milton-Freewater. I did not find any places on the graveled section, No. 3 soil, where the natural gravel would indicate that the water was closer to the top.

(1174) I have a soil survey bulletin that was of a survey that was made in the Mill Creek area of the Walla Walla Valley, in 1902, by Mr. Garnet Holmes, a soil surveyor.

In this soil survey he did not have nearly as many groups of soils as they are grouped now, because of the practice at that time. But the groups that he did pick out--that he did mark on the soil survey map at that time were accompanied by a text showing the mechanical analysis of the soil.

In his description of the soil he called this No. 3 soil, which is quite definitely marked on the maps on the Washington side, in the relatively same position as they are now,—his descriptions were the gravel ran from very small size, from one-third of an inch up to cobblestones, the depth of the soil carrying down pretty well for two feet, which is the description that fits the sample No. 3.

And the location of the sample as located on this map (Washington Exhibit 15) was in the northwest corner of No. 1140 of section 19, township 7 north, range 36. That point is in the center of this No. 3 area, a little bit to the south of the center of that strip when you consider the line north and south.

Now, the mechanical analysis of this sample as made by government soil surveyor, as far as the screenings, mechanical analyses go, it is fairly comparable to the same method used today in mechanical analysis. The gravel—it is called gravel—the size of two millimeters to one millimeter. This, of course, is not the whole soil, but the fine earth of that soil. There was 3.12 per cent of gravel of that size. Remember, considering the fine part with the big rocks taken out—the coarse sand, one millimeter to .5 of a millimeter, 6.26 per cent.

Medium sand, .5 to .25 of a millimeter, 3.92 per cent.

Fine sand, .25 to .1 of a millimeter, 11.5 per cent.

Very fine sand, .1 of a millimeter to .05 of a millimeter, 21.7 per cent.

Silt, .05 to .005 of a millimeter,—44.34 per cent.

Clay, .005 to .0001 of a millimeter,—7.88 per cent.

This soil survey is entitled The Mechanical Analysis of Yakima Gravelly Loam, Fine Earth, and under the third column it describes it as Gravelly Loam, Zero to Twelve Inches. That means the depth of the first foot. There is not any indication whether or not or how much, any larger stones were taken out.

As to the stage of development and thickness of population on the No. 3 soil area on Mill Creek, shown in orange on Washington Exhibit 15, the No. 3 soil area on

the upper parts of Mill Creek is quite extensively farmed and also the No. 3 section in the lower part here in section 22-7-36 is particularly extensively cultivated. And just to the north of that in section 15 and part of 16—there is considerable land that is idle in that section—and in the part southwest of Walla Walla there is one area of the No. 3 on Stone Creek that is very extensively cultivated—farms there even in the gravel will grow vegetables, and just to the west, the tips of this No. 3 and 2-B area here, southwest and exactly west of the City of Walla Walla, section 19 and the section below 19, are quite extensively cultivated.

At this place Washington Exhibit 46, being the Mechanical Analysis of No. 3 Mill Creek Soil, identified in the record as "the soil survey of 1902" was introduced in evidence.

WILLIAM W. JOHNSTON, for the State of Washington, testified in part (938-998):

I am Reclamation Economist with the United States Bureau of Reclamation, Department of the Interior. My duties under that Department consist essentially of the agricultural phases of the work that the Bureau has to do, including the classification of lands, the investigations of duty of water, and certain economic problems connected with the repayment of water charged, the ability of lands to repay charges. I have been with the Department in my present position a little over 8 years. I have a B. S. degree in Agriculture in the Drainage and Irrigation Departments, from the Oregon State Agricultural College. I was field agent for the U. S. Department of Agriculture engaged in duty of water experiments for about 4 months in 1917. I was a member of the faculty in

the Soils Department of the Oregon State Agricultural College from April, 1919, to October, 1925, engaged largely in soil and irrigation investigation work. In the year 1924-5 I was on leave of absence as a Research Fellow at the University of Missouri, at which time I received a Master of Arts degree.

My investigation locally has been for the purpose of familiarizing myself with soil and agricultural conditions, with a view of determining the water requirements largely on the basis of comparison with use in projects where I had made investigations. I have made an examination of the types of soil here. I have attempted to acquaint myself with the irrigation practice in this locality. I have spot-checked this soil map (Washington Exhibit 15) in the field in certain places to check on its accuracy. I found the map sufficient for my purposes. I am acquainted with Mr. Youngs' methods of classifying soils. I just met Mr. Youngs at one time. However, I have had occasion to use his maps on several other projects, and I have found them in those cases to be very accurate soil survey maps. From the investigation I have made here, it is my opinion that the soil classification shown on the map (Washington Exhibit 15) should be grouped to arrive at the practical division of soils for water requirements determination. I recommend the same grouping which has been described—that is, the real gravelly, shallow soils which are Class 3; of the next group, which is slightly deeper, but more or less associated, 2-B, those two being grouped together; that the remaining types be grouped in the second class. They subject themselves to that grouping as to their water requirements. The variations which occur cover only small

acreages. For the purpose of my testimony we will refer to the gravel group as Group B and the balance as Group A.

For Group A I would recommend one-half miner's inch per acre,—that is, as a diversion duty at the point of measurement, which would give practically the peak month a diversion of .74—if I might refer to my notes here—gives for the peak month the diversion duty of .74 of an acre-foot. I would estimate losses in this class as fifteen per cent, which would make at the land a duty for the peak month of .63 of an acre-foot.

If the water rights are to continue on the basis of continuous flow, this would make the requirements for the six and a half month season approximately 4.81 acre-feet per acre.

My conclusions for group B would be a diversion of .9 of a miner's inch per acre, which would give 1.34 acre-feet as a diversion duty in the peak month, and one acre-foot of which is estimated would be delivered to the land. That is figuring a transportation loss of twenty-five per cent (942).

With a continuous flow that diversion would be approximately eight and a half feet at the land, based on six and a half months season. I took into consideration in arriving at my conclusion as to water requirement the local conditions as compared to other projects where I had had time to make careful determinations.

The principal basis of this determination is the study I made in the Sunnyside valley in 1930 and 1931. The work, as I say, here, has been to adapt that study to these local conditions.

I have made studies in other projects over the country. The duty of water has been one consideration in practically all the studies that I have made. I could not list all of those for you. The ones, though, where the duty of water was measured, would be one that I have just completed on the Verde district in Arizona, the Gooding project, the extension of the Minidoka project, the Casper project; those are projects where the duty of water has been a matter of major consideration.

I am familiar with practically all the projects under the Reclamation Service, possibly 3 or 4 I have not been on. The investigation of the Sunnyside division was a determination of duty on what are known as the supplemental contract lands; that does not include all of the Sunnyside division; these are lands that were formerly in the Washington Irrigation Company, taken over by the government in 1905. The total area I covered was approximately thirty-six thousand, six hundred seventy-three acres.

I selected the Sunnyside division as having application here because the conditions were more nearly similar in climate, in method of delivering the water; that is, they used small irrigation heads, and a large part of the soils was comparable, and the remaining soil, the Class 3, falls between the two types, in my opinion, of that determination, so it gives, I believe, a good method of comparison (944).

The plan followed in the Sunnyside division of the Yakima project was, in the first place, to make careful classification of the land on the basis of water requirement. In doing this I went over all the land myself, I had

a helper, and put down test holes, put down an average of one for every ten-acre tract.

Each of the various ownerships was examined, notes were made as to the length of run, and furrows, the apparent care with which the landowner handled his water, the crop appearance, whether there was indication of excessive use or lack of water, and the acreage in different crops.

Then from the records at the Sunnyside office the actual water use delivered to each of these tracts was compiled for a period of eight years. The only reason the eight years was used, we started out to get a ten-year period, but didn't have time to get the other two years. But we considered eight years would be representative.

I then had the actual water measured to the land, to consider in connection with this field study. On this basis I divided the area into five classes. We then summarized the actual water delivered to a farm for each of those classes for the eight-year period which formed the basis for the duties that I recommended; that is, these amounts were modified to the extent that my field study showed there was a gross over-use of water or that they had not used enough water or that excess water had been used early in the season as a matter of project administration; that is, the water there is delivered on constant flow basis; I believe seven hundred miles of canals and laterals. Since it is continuous flow, it is necessary to get that all spread out, and in order to have the system working when the water is really required they encourage the farmers early in the season to in some cases use water so that they can get the needed amount spread out into the ditches and into the laterals.

The government took over these lands at Sunnyside in 1905. These were lands which had a water right, an established water right and had been used prior to 1905. These were lands of the Washington Irrigation Company. When the government came in they purchased the canals of the Washington Irrigation Company and contracted to deliver water according to their contracts with individuals. I do not have the information at hand as to exactly when these lands were first put under irrigation, but they are the oldest, practically, of such lands in the Yakima Valley irrigating.

The first matter in making a comparison of what I find here in the Walla Walla Valley, with the Yakima project, is a matter of climate, to see whether the climatic conditions were enough similar to warrant using that data. I have here the 1933 climatological summaries for the states of Oregon and Washington from which I have made copies of the amounts on two tables here. One shows the annual precipitation for the year 1933 by months, together with the departure from normal, from the stations at Walla Walla, Milton and Sunnyside. I have calculated from the amounts in 1933 and the departures the normal rainfall.

I might say that these reports do not give that calculation. They simply give the amount in 1933 and the departure from normal, so I have calculated that on these sheets.

We find that the normal rainfall in Walla Walla is 17.01 inches per season. In Milton it is 14.41. In Sunnyside it is 6.48 (947).

In comparing the amount per month it will be noted that July is not as dissimilar as are the other months, but

even then the rainfall in Sunnyside is appreciably less than at Walla Walla and Milton.

In June, for instance, the rainfall at Walla Walla is 1.12, at Milton it is 1.01, and at Sunnyside it is .38.

So that I believe in every month the rainfall here has been greater than at Sunnyside.

Now, I have concluded from that that from the standpoint of natural precipitation this area had some advantage over Sunnyside.

The other sheet which has been handed out is likewise taken from those climatological data from those two stations, and shows, first, the approximate elevation.

It will be noted that Walla Walla is 991 feet above sea level, Sunnyside 740, Milton 1100.

The annual mean temperature is 54.5 at Walla Walla, 51.5 at Sunnyside, 53.4 at Milton, showing that the annual mean temperatures here are slightly higher than at Sunnyside, but it is interesting that the maximum, the high, is 104 in each case.

There is likewise, on the right-hand side of this table, given the number of rainy days, Walla Walla 114, Sunnyside 69, Milton 82.

The number of clear days is highest at Sunnyside, being 212 as compared to 115 at Walla Walla and 128 at Milton.

Number of partly cloudy days is likewise considerably greater at Walla Walla and Milton than at Sunnyside. The same is true of the number of cloudy days.

Now, from these data I have concluded that any higher water requirement in the Walla Walla country here that might be brought about by the higher mean

temperatures would certainly be balanced by the greater precipitation and the larger number of rainy or dark days.

I do not claim from that that these small amounts of rainfall in the summer will have much of an appreciable effect as far as that individual amount of rain is concerned, but the lower transpiration and the lower evaporation during rainy periods does have a marked influence on the irrigation requirement, so that if there is any difference I would say the climate would indicate a lower water requirement here than at Sunnyside. However, in my determinations I assumed that that factor was the same in each case.

In the classification at Sunnyside I used five classes of soils.

The duty Class No. 1 was made up of water-logged lands. They were generally naturally fairly smooth, since they were water logged, and usually of medium texture, but they were lands where the water table was so high that they were not given regular irrigations.

The next class was made up of smooth lying, medium textured lands, where the water table was high enough to have an appreciable effect on the irrigation requirement. These areas were regularly irrigated and had to be irrigated to produce crops, but the water table did have some effect.

Then the third class includes the well drained, medium textured soils which really make up the bulk of the good land in the Yakima country, the area in the vicinity of Zillah and the general well drained, medium textured soils in that vicinity.

Now, the latter type compares very well from the standpoint of the irrigation requirement, in my opinion, with these various phases of the type 1 that we have here.

The 1-D would include lands that are similar to those that I have put in the Classes 1 and 2 at Yakima. That is, I adopted the areas which were sub to the extent that they needed practically no irrigation from those which were still subject to needed irrigation.

Then the 4 and 5 which are here, are a class that would compare with lands that I put in at Class 3 at Yakima.

Now, when we get to the gravelly types here, they are more nearly comparable in water requirement, in my opinion, to the two other types at Sunnyside. The type 4 at Sunnyside was made up of soils which were less than 3 feet either to gravel or to basalt (950).

Now, the area to the east of Grandview for a number of miles and clear south to the river is underlaid by gravel at various depths; there is quite a variation there in the depths to gravel. Then these basaltic soils occurred more down in the vicinity of Prosser. However, it is not the same type as Mr. Larson described as on the Experiment Station. It is down in the valley proper, below the type up at the Experiment Station.

Then the last class, Class 5, was made up of the extremely porous, sandy soils, which were scattered over the project, the larger acreage being in the land south of Snipe's Mountain.

Now, the use records on these various types for the eight-year period as averaged were, for the type 1, 1.59

acre-feet per acre, with the peak months of July using an average of .39.

The type 2, which, as I say, is partly subbed, used an average of 2.88 acre-feet per acre, with .57 acre-feet per acre in the peak month of July.

The Class 3 used an average of 3.98 acre-feet, with .74 in the peak month.

The type 4, which was—that was less than three feet either to gravel or to loose basaltic rock—used 4.66 acre-feet per acre, with .85 in the peak month.

Now, the Class 5, these extremely sandy soils, used an average of 6.74 acre-feet per acre, and 1.21 during July.

Now, these use records can be explained a little further here to make their application here be clearer. These are averaged by ditch riders' beats. The reason we did that was that these beats include lands more or less under the same part of the lateral system, and also because they divide the area according to the different locations of the project.

Now, there are two beats here in which all the uses in all these different classes were much greater than any of the rest. *One is Beat 8, which* used for the—I had no Class 1 in that, but Class 2 used 4.02 for the season as compared to an average of 2.88.

The Class 3 used 5.04 for the season, as compared to an average of all the beats of 3.98.

Class 5 used 8 acre-feet per acre as compared to an average of 6.74.

Understand that, to the best of my ability, the classification in each of these beats included the same type of

land, the same type of irrigation required. The topography and drainage entered into that, as well as the type of soil.

Now, the second beat which had irrigation uses considerably in excess of the average was in Beat 12. Naturally I had to go into that quite thoroughly to decide why these uses were so much greater in these beats, and I found that these happened to be lands which used the tail water from direct-connected pumps, these direct-connected hydraulic pumps which serve lands in the Outlook and Snipe's Mountain and one other pumping district there. While these were designed to utilize just the water for pumping that would have to go down to those lower laterals, in actual practice they push more water through in order to pump the water needed on these upper lands, with the result that under lateral 8, for instance, there was a large head of water going by all during the irrigation season which would be wasted back to the river if it wasn't used, consequently in the administration of the project they let these water users use practically all they wanted to of that water (952).

Now, these rights that I have been referring to here, these old supplemental rights, had contracts with the government which gave them the use of water after paying a certain amount for the supplemental storage—the maximum, I believe, was sixteen dollars an acre—but after that they only had to pay one dollar per acre for operation and maintenance, and the contract read that they should have three acre-feet or as much more as in the judgment of the authorized government agent was required to produce a crop. The result was that no matter how much water they used they were only charged a

dollar an acre. That was in contrast with the so-called public notice lands, where they paid in most years two dollars for the first three acre-feet, unless they were in a classification that gave them more water than that, and any additional they had to pay a dollar and a half an acre-foot; so that the use of water in these two beats, as near as I could find out, was practically all that the farmer wanted, and in addition it cost him no more to use a large amount than it did a small amount, so that that accounted for those heavy uses in those two beats, and the average without them would have been considerably under the figures that I read to you.

Now, the recommendations I have made, I believe, for this A Class, compare very favorably with these uses, when we consider the excesses that I found there, and in the case of the B lands that we have here the comparison as far as soil goes is not so exact.

The 2-B portion of our soils here, which we have thrown in that B type along with the 3, would compare very closely with the gravelly phase of the Class 4 type in Yakima.

Now, the 3, the Class 3 here—excuse me, the type 3, is a different soil than any large body up there, although there are small areas within this 4 type which would correspond in water-holding capacity and in the porosity of the soil. The sandy lands in that vicinity differ from these in water—I should say, in the irrigation practice required, in that the large amounts there are necessary because of heavy percolation losses in irrigation rather than on account of the small water-holding capacity. On the other hand, in my opinion, these Class 3 lands here, the high water requirement is not due to

the fact that you cannot spread your water readily in irrigation, but it is due to the fact that the water-holding capacity is low and you have to irrigate more frequently than you would otherwise.

The top soil on this No. 3 land in the Walla Walla territory is a coarse, stony and gravelly soil. In the examinations that I made, I found that to a depth of about sixteen inches the soil in between the stone and gravel is of fairly heavy character. It is difficult to make a real finger analysis, because the small pieces of rock in there made it feel rather gritty, but it must contain a considerable amount of colloidal material. I would say that if you could screen the rocks out, the soil that is left would be at least as heavy as a silt loam.

In view of the type of soil between the rocks in the No. 3 soil, this type of soil would require less water than the Class 5 soil, which was the real sandy soil, in the Yakima Valley, but probably a little more water than the Class 4, which included the fairly good soil underlaid with gravel.

Since I have only been here a short time, I had to arrive at my conclusions regarding irrigation practice in the area with No. 3 type of soil in Oregon, largely from examining the farm irrigation systems. I would say that the irrigation practices are far behind the general agricultural practices. In fact, that is very striking, and on small farms, very intensively cultivated farms, you find the conditions of irrigation furrows, conditions of head ditches, the method used in making furrows, of a type that you would expect in an area which was—in a cheap area, where the farming was very extensive.

As to water-saving appliances in evidence in that territory, I think I saw one flume about a hundred yards long up near Milton. You could see it from the road along there. That is the only thing that I saw of that type. I didn't see any turning-out devices from the laterals to the land, for saving water.

There was very little irrigation going on in the territory. I can remember of about three places where I saw water being used. With respect to corrugations in the Milton-Freewater territory, I found that in general in the area I was able to see in this short time, the irrigation runs appeared to be quite long. Now, in stating that I would define what I mean by the irrigation run. I mean the length of the furrow from the real head ditch, delivering ditch, until there is another head ditch. That would not mean the length or the distance from the head ditch to a point where a pick-up furrow is crossed (956).

As to the practice of putting in pick-up ditches at intervening points between the place where the water is turned on the land and the lower end of the land, it is, of course, desirable to pick up any necessary waste that may be had from furrows of the proper length, but the more efficient practice would be to have a second head ditch, so that when you are irrigating your second run, except for what little you get from those furrows, you can have a run down there in a single ditch. If you irrigate ten furrows, for instance, out of the upper run and pick up water that runs out to the end and irrigate five furrows below, you are using, really, ten delivery ditches to get at your second five furrows.

I wouldn't consider the practice of having 18 to 20-rod rills down to the pick-up ditch and a second line of

rills of approximately the same length from the pick-up ditch to the lower end of the tract, on the No. 3 soil in the Milton-Freewater territory as good irrigation practice. The effect is almost the same as if we had a run of 660 feet instead of 320. Short runs is to prevent the over-percolation of water in the upper area of irrigation and the purpose of the second head ditch is to thereby shorten the run to prevent the early over-application of water.

The length of run in the vast majority of cases in the Yakima Valley is 320 feet. In some of the sandier soils, it is shorter than that. On some of the heavier soils, particularly the areas with hardpan and somewhat alkaline areas, the runs are twice that distance, or six hundred sixty feet.

While I do not have all my notes here to be sure, I don't remember of any run over six hundred sixty feet, unless it would be where there was a triangular-shaped piece and there might be a few furrows at one end that would run longer than that. The vast majority were three hundred twenty feet.

In row crops the practice with respect to cleaning out ditches is almost a hundred per cent to cultivate as soon as possible following the irrigation and until such time as that crop gets up to where it will shade the ground and to where cultivation would break down the plants, but otherwise to cultivate after each irrigation. In orchards with a cover crop it is practically always—that is practically always done there in cases that come under my observation, that they clean them out between irrigations,—clean the furrows out, that is. Of course, they do not recultivate the whole area.

There is no peculiar physical condition in connection with Class 3 soil in the Milton-Freewater territory which would make the distribution of water on the land particularly difficult, as far as the individual irrigation is concerned. The soil apparently subs quite readily. I have found, from the few farmers I have been able to interview on it, it is possible to get the water through a run of twenty rods in about two hours without washing. That indicates the deep percolation as far as that individual irrigation goes is not so bad but what they can spread the water very rapidly in the surface soil.

The colloidal nature of the soil is an advantage but it may present some problem, in that if an irrigation furrow is not cultivated following irrigation, be more of a tendency for it to bake; if the second irrigation came on without that being cultivated it would be quite possible considerable water would run through without percolating into the soil.

In my opinion it would not be necessary for the shallow soil included in Group B to lose a great deal of water through deep percolation, if the proper irrigation system were followed.

I would say that my allowance for Group B was comparatively liberal, when you consider the nature of the agriculture here. The principal thing, of course, which has led me to reach a conclusion as to the liberal allowance, is the peak requirement. It is necessary during that period, in my opinion, from about June 15th to August 15th, to have a fairly large supply of water, so when the duty is applied on a basis of continuous flow it makes the total extremely high. However, I believe the

amounts I have recommended are liberal for that period —are sufficient for that period.

The estimated transportation loss is liberal when it is considered that the distance from the points of measuring are extremely short. I believe considerable improvement could be made to reduce transportation losses, without any great expense. It would be expensive to line the (ditches) and stop all losses, but I find in these ditches the banks are undercut, frequently the fall is so excessive in places that there is a tendency for the ditch to cut to one side or the other. There are many cases where the weeds are grown up along the edge, which cuts down the flow. The simple proposition of going in there with a shovel and cleaning up the ditches would make a measurable difference in the amount of water delivered (961).

As to whether on irrigation projects places of excessive loss are improved with flume or pipes or concrete lining, something of that sort, depends on the intensity of the agriculture. If it is in an area where they have large farms, and per acre crop returns are low, they ordinarily do not go to so much expense to fix up their ditches. In areas where the water is valuable and the agriculture is intensive, it is customary wherever there is an excessive loss to line it, put in a flume. Of course, there are cases where it can be improved by holding down the grade, allow it to silt in. There are many things that can be done to save water, which are not expensive, that (might) be applied in this territory, I would say, from what I have been able to see since I have been here.

I believe that the use of a greater amount of water than I have determined as the water requirement here, in general would be more apt to be harmful than beneficial,

when you consider all factors. It might not, as far as one area is concerned, but particularly on the shallow soil like we have here, the loss in fertility from excessive irrigation is really an important factor.

To illustrate that, that is not entirely a theoretical proposition,—I found several years ago, upon talking to several of the best fruit-growers on the Okanogan project in Washington, upon the Okanogan River, near where it joins the Columbia River—that those farmers, who were extra good fruit men, found—gave the opinion, at least, that they were able to get much better use out of sodium nitrate fertilization than they did at Wenatchee. They attributed that to the fact they used so much less irrigation water than at Wenatchee.

I can not substantiate that one way or the other. But I give it as an opinion that is prevalent among the better farmers.

In my opinion, the amount I have recommended is all that could possibly be beneficially used, considering the condition in that territory, with the methods of farming, methods of irrigation and character of irrigation which is consistent with the other farming operations. In fact I believe that Stipulation No. 7 on file in this case is for a lower duty but I did not feel justified in recommending that much water.

(963) I went to school under Dr. Powers at the Oregon State College, at the present time am released from the government work, and am here at the instance of the State of Washington.

I have had the opportunity to observe considerable irrigation on stony, gravelly soil. I have not actually,

myself, handled the water on it. I have not conducted duty of water experiments on the kind of soil we have there around Milton.

There are small areas of the Sunnyside Division down near the river that are stony and gravelly. They were not, however, sufficiently large to make a separate classification for them. The classification as to soil in Sunnyside, that I refer to, was made entirely by myself except that Dr. Powers was brought in for a few days to review my work and to advise with me. There was a prior classification made there for what are known as the Public Notice lands, which are a part of the Sunnyside division, but this was not the area I covered. The prior classification (of Public Notice lands) was made by representatives of the local irrigation district. I understand it was based on a study made by Professor Harding, but the actual classification was made by the district. I presume Professor Harding is familiar with the class of land in the Sunnyside district. Dr. Powers, in his review of my studies, also became familiar with it. However, at that time, he was only there a few days, but he had a chance to see the different types. I do not believe that he was there much longer than I have been here upon this particular matter. I do not recall exactly the time.

I started my investigation here last Friday, March 30th. (NOTE—The witness testified Wednesday, April 4th.)

In the study of water requirements of any particular soil, the problems of distribution affect the amount available at the farm. You have to consider the rise and fall of the stream, if at the low point it gives you a water

shortage. The minimum amount is not necessarily the only basis you can really consider in the distribution of water; depends on how long those low peaks would last. You could adopt a mean in such cases unless the low periods were of several days' duration. Whether the irrigator that came in on the low point of the water supply would suffer, will depend on the length of time those shortages occur. I would say if the distinct difference between the water available lasted over a period of a week, it would have that effect. Whether if the sudden rise last one day, the irrigator on that day would get an over-delivery, depends on your method of handling water. If there are simple division weirs off of the various streams that are wide so a quick fluctuation in the elevation of the water would push a great deal into that small canal, it will make more difference than if that is not the case.

The amount for Class 5 of 6.74 acre-feet on Sunnyside are the actual measured measurements, but it is the mean for a period of years. As far as I was able to find out, the years where they used less than that, did not represent a shortage of water in use. The difference there was more apt to be due to a difference in cropping, because they are the lands in the Sunnyside which have had the most water. In computing that amount for each year, it would be the delivery divided by the acreage in each class. In the duty up there I considered the mean per acre-foot supplied per acre; I likewise gave considerable consideration to the fluctuation and the amounts that I have mentioned here are not the duty I recommended; those are the actual measurements released.

I did not mean to give the impression that the fluc-

tuation in the amount of water used by different farmers was caused by the change in crops. If I said that, I misunderstood your question. I meant that the mean use in one year compared to the mean use in another was affected more by crops and climatic conditions than it was by the available water supply. The crops which a farmer raises have some effect on the amount of water he uses. A lesser supply of water would not necessarily change the character of crops that some of the farmers would raise. Any reasonable duty recommended would not change the character of the crops. It might change the acreage in certain crops in any one year. I have never heard of a duty of water being determined on the basis of the peak requirement of any one crop. If this man raised his entire acreage in some crop with an exceedingly high peak requirement it would require a change to a reasonable rotation of crops (970).

As to whether in order to permit the versatility of crops in a district like the Milton district, it is necessary that the decree should be fixed at the lowest duty of water that any crop which they raise would require, I can't say as to the court decisions, as that is entirely out of line with the experience I have had in water requirement, with the Bureau of Reclamation or elsewhere. The duty of water should permit the growing of a reasonable portion of a man's acreage in that type of crop. The supply of water itself will not necessarily affect that proportion. It isn't good farming practice, regardless of your water supply, to put your entire acreage in any one crop, from an economic standpoint or the agricultural standpoint. I wouldn't say that the prosperity of the irrigation project is almost entirely reflected by the

quantity of water that it has available. I would say that the prosperity of an irrigation project is limited if they do not have a sufficient supply, but is certainly not in direct proportion to the supply of water they have. The land values and the diversity and the intensity of the farming do not decrease as you decrease the amount of water, if the amount is not decreased below what is actually needed for a reasonable rotation. Long years of farming is the best demonstration of what is actually needed, unless they have farmed with an almost unlimited supply of water. Farmers ordinarily will not adapt themselves to good irrigation methods if they have an unlimited supply of water. That is very clearly illustrated by the comparison of the water used on these beats that I mentioned. The type of agriculture and the prosperity of agriculture under Beats 8 and 12 in the Sunnyside is distinctly inferior to that on the average of the other beats.

The fact that the farmer is expending money for pumping would not necessarily be proof that the total amount of water he used was a beneficial use. We have seen evidence in quite a number of cases. For instance, a man might do that for the purpose of getting a larger irrigation head instead of rotating, and that would not necessarily hold, in my experience. In the long run it would be a general indication in that direction.

In determining the length of runs, I would say that if the actual length of run from one head ditch to another did not exceed 20 rods that that would not be out of line for that class of surface. That would be the maximum. If after years of farming and experimenting with longer and shorter runs, the farmers had generally

adopted a 20-rod run, that would not be considered what would be best in those instances, if they had had an unlimited water supply. As I said a short time ago, a farmer will usually not adopt better methods as long as he has an unlimited water supply. He will substitute the extra water for other improvement which might be more profitable. I have not been over the lands out here during the irrigation season when everyone was irrigating. All I have seen of their preparation of runs for irrigation is during the last few days. Quite a number were preparing their ditches and runs. Over-irrigation of the soil near the head ditch on No. 3 lands near Freewater would occur if the corrugations were not properly made and the head of water properly regulated as to size. If a man would run an extremely small head so that it would take maybe ten hours to get to the lower end the chances are he would over-irrigate the upper end. The corrugation, in the first place, should be made with some sort of a shovel plow. I found some of them out here made with a mold-board plow, an ordinary plow, and I would say under this condition that the corrugator should be followed with some sort of a log or appliance of that sort which would smooth it out and to make a smooth, even furrow.

The slope of the land might have some slight influence on the type of furrow. Where the grade is 60 feet to the mile, the rapidity with which the water would flow would not necessarily prevent over-irrigation next to the head ditch. It would depend entirely on how it was handled. I have seen farms in the Yakima Valley with a fall of better than 20 per cent in which they would use such small heads that they would run water there for—

well, I know of instances of thirty-six hours—they would run such a small head that it would waste very little off the lower end and probably not reach the lower end for twelve hours. Under that condition it is possible, even with a very steep head, to have excessive percolation losses at the head end. The particular instance I mention was on a different class of soil, but the soil, as far as the first foot, was lighter and more apt to wash than this soil.

In case of a row crop, I would cultivate this class of soil after each irrigation. It certainly should be done up until the time the growth of the plant reaches a point where cultivation would interfere with it. At that time it would practically shade the ground. I believe I stated that the cultivation should be done up until that time.

If they get in there with an ordinary cultivator and smooth off the whole area, of course, they would be unable to conduct the water through the run, but the cultivation that I have in mind would be largely a matter of simply running a furrower through again and cultivating the furrow itself. If cultivation were the limiting factor it would seep away more, but if your cultivation was such that you did not have a well-formed furrow left, why, then your water would not follow the furrow and your loss would be much greater. I am sure that the porosity of this soil would not be a determining factor whether or not you cultivate. As an abstract question it might be (977).

I made no soil tests other than soil examination of profile for comparative purposes. I made no determination of the soil content and capacity. I made no laboratory tests.

The holding capacity of the soil in the total profile, which the plant would have a chance to use is much less here than in the No. 5 soil on the Sunnyside Division. The soil mingled with the rocks, the soil itself, here is not similar (to that on the Sunnyside Division). (The holding capacity of) this would be a great deal higher. The soil itself in with the rocks here would be a great deal higher than that sand at Sunnyside, but the fact that it is so shallow and the volume is decreased by the amount of rocks in it, makes the water-holding capacity for the whole profile of the soil here less than that sand would be, as a general rule.

I made an allowance for that. I didn't make a percentage allowance. As I believe I indicated, the limiting factor on this soil is the water-holding capacity, but the limiting factor on that (Yakima) soil is the amount of deep percolation that is necessary in order to cover it. It was my opinion that the latter would be considerably of more importance in lowering the duty than the limited water capacity of this soil.

The flowing of water through the furrows tends to silt them and make them carry water better than when you first start to use them. The disturbance of that silted part of the ditch would open up the seal, which would permit it to increase percolation and likewise increase the lateral movement and the speed of subbing the soil. Assume you break the seal and you have a porous furrow, the percolation to the gravel stratum would be much less with a high head of water than a slow stream, because you would get your water to the lower end of the furrow more quickly.

I wouldn't say that the custom of lining or fluming ditches is more general in government projects as a whole than in private projects. It is more general in the near-by government project, the Sunnyside division. I don't know of any particular difference in that respect between government projects and private individuals. I cannot think of any particular instances that would permit a conclusion on that. My experience has not been confined almost entirely to government projects. We have had quite a bit of investigation work on other projects, projects that are partly developed, requiring storage works. My experience would be more nearly confined to projects either government, state or irrigation companies than to private farms.

The government has not adopted a policy of completing the lining and fluming of ditches on the average of the projects; really very few projects, when you consider the total, where this lining has been done.

I would say that in and around Milton it probably would not be economical for the private farmers there to line or flume their ditches to any extent under present conditions, with the exception of the real small, very intensive small ranches; I believe in those it would pay to have some sort of flume regardless of the water supply (982).

I did not notice the pipe line near the tail race of the Peacock Mill on the Little Walla Walla across the gravel belt to the Loundagin tract. I saw very few of the diversion works. I didn't look at them. I didn't observe whether they were tightly built. I didn't observe any waste in that regard. I took no particular observations upon the Hudson Bay Ditch. It is a general thing

over the northwest in the irrigation projects for the amount of production of alfalfa after the virgin fertility of the soil has been used to a certain extent to fall. I know that the production of alfalfa has generally decreased.

The time between irrigations on the 4 and 5 Classes of soil in the Yakima project for orchard tracts, as I remember it, would run in the heat of the summer not oftener than two weeks as a general rule. For alfalfa there were only three or four irrigations per season. For potatoes during the real growing season, after the crop had gotten up in good shape, were usually once a week. That practice was followed for both early and late potatoes. But the irrigation continued longer with the later potatoes, and started at a later time. The year that I was in there I believe the greater proportion was late potatoes (in the Yakima project). The irrigation of alfalfa for only three or four times during the season would indicate that the soil had a large storage capacity. I do not have the figure in mind well enough to (state) how many acre-inches they would apply for irrigation in the orchard tracts there. It would generally be close to 6 acre-inches; depends on the soil. It would be perhaps a little less on Class 4, and considerably more than that on Class 5. The conditions between Classes 4 and 5 are so different that I don't know how to make an average for a class that would come in between 4 and 5. If I may explain, the factors which give the high water requirements to the Class 5 land on the Sunnyside project are entirely different from the factors that would influence the requirement on a fairly tight soil which is shallow. It is not that that soil does not hold the moisture but it is that

the percolation is so rapid that you necessarily lose an enormous amount of water in getting over the field, so it is hard to make that average for the amounts per application. Where the percolation is rapid as it is in that sand, it requires an enormous amount of water to get over the field in one irrigation. I do not consider that that would apply to No. 3 soil around Milton and Freewater. This soil here is heavy enough in texture that in my opinion they can apply light irrigation successfully. The reason it has a comparatively high irrigation requirement is that you have to irrigate so often. I considered in my opinion in that regard the underlying soil and depth of the gravel. My judgment has been based on the understanding that the average, about sixteen inches, is made up of heavy soil in the gravel, and that from there on down to the cement gravel it was exceedingly porous. I don't think that from where the soil ceased to be mixed with the gravel, it would be a cement gravel. I think it is very loose gravel from there down, gravel with coarse sand in it, coarse sand and fine gravel mixture, but very porous, very loose (987).

The percentage of the water applied that would be held in that first 16 or 18 inches would depend entirely upon the way in which it was applied. If the water was allowed to run in those furrows for a long period of time, say twenty-four hours or three days, something of that sort, there would be an enormous loss to the subsoil, but it is my opinion that that can be irrigated very readily without serious loss to the subsoil as far as that one irrigation is concerned. I don't believe that there would be a big percentage of loss through deep percolation if they only ran the water for a period of about three or four hours along those furrows in making their changes.

Assuming an orchard and a cover crop, I would want the length of furrows not more than 320 feet; then I would put in furrows that were of moderate size. I believe many of the furrows that have been used are too deep and has the water down too deep into the soil. These would be smoothed by following the furrower with some sort of an attachment that would smooth the ground to a certain extent. Then it is a little difficult for me to recommend the distance apart with the information I have, but I would think there should be not more than four furrows between the tree rows, possibly three. Then at the head ditch, the head ditch should be kept free from weeds. It should be on a grade, so as to permit a certain amount of silting, if that is possible—it may not always be possible, although usually checks can be put in to control the grade. Those checks are helpful, too, in getting your water out of the head ditch and into the furrow, so it would not be put in entirely for the purpose of lessening the grade. But it would be advisable to have some sort of checks in there that could be handled with a gate rather than to fill that up each time with a shovel. Then I would put some kind of controlling devices, either what they ordinarily call spiles, a tube affair made out of lath, or sometimes you can purchase them made out of tin, or in some way I would have some kind of a metal affair which would keep a constant head, or allow you to control your head, going out of the head ditch into the furrow. Then the irrigation should proceed at a rate—the size of head which should be used would need to be one which would get the water down to the end of that row in a comparatively short period of time, if possible about two hours. I am not familiar enough with the soil

to say just what that length of time should be, but then it should be cut down and new furrows opened and just enough water allowed to pass through there so that there would be practically no waste at the lower end. I believe that the total length of time of from three to four hours in that way would completely irrigate the orchard; that longer periods would result in excess percolation (990).

Where you have a five-acre tract, it would be very desirable to have seven and a half miner's inches for the head, but they have used (the plan I have outlined) on the Sunnyside division with a still smaller head. With a gravelly soil, as the number 3 soil is, I would think you would need a good-size head. I am not prepared to say just how many inches it should be, but if you had a place as small as five acres I would say that you would need to rotate in order to use that amount of water.

I would not be prepared to state just at what acreage I would stop at. On the Sunnyside division I took the use records of the actual delivery to the places as the basis upon which to fix the amount of water required. The actual use was not, however, my recommendation, but it was a basis of it.

The experience and judgment acquired by reason of long farming needs to be considered in fixing the number of applications of water. The judgment of the man upon the ground should not necessarily be relied upon. If you have nearby areas that had amounts of water which vary from that you can get your ideas settled better by comparing. For instance, the use of water in a certain tract where they have been practically unlimited, see how their practice and results compare with the use of water on another tract where they have been limited. I have consid-

ered this phase as well as I have been able to, in the time here. I don't know that I have read all of the testimony that has been produced here in the transcript as to the time of application (of water). I read part of it.

On the Sunnyside division the use records that I considered were gathered by measurements at the edge of the farm at the point of delivery. In that particular land over there, just a portion of the Class 4 was a basalt formation within a very close range of the top. In the portion which was gravelly from the cuts that I examined, the basalt formation was not usually below the gravel part. In the portion of this area which was gravelly, the gravelly strata was deep. There were certain of the basalt lands which had broken up basaltic rock which you might call gravel before you hit the solid rock, but in the area I referred to as gravelly they were alluvial deposits which were not to the best of my recollection underlain with basalt. I made no analysis of this Class 3 soil for fine earth or percentage of stone and gravel. I made no detail examination of the soil in the area near Lowden at the west end of the stream basin. However, we drove over that and stopped from time to time to look at cuts and banks. As I remember, the land in Class 4 in that vicinity was largely salt grass land. I believe there was considerable in 1-D (993).

Assuming that Class 4 in 1-D land had an early water right, and after having observed the development upon Class 3 up by Milton and Freewater, I would say that if the better developed lands were injured by taking the water away, in other words, if we took water away which was actually needed to raise crops, that it would not be an economical use of water.

In the development of salt grass and greasewood land, that class of land is being eliminated to quite an extent from projects at the present time. However, let me explain, lands of that appearance, I have not examined those to the extent that I would know whether I would class them out in the land classification or not.

I have had experience in both types (of water supply) on our projects. Where the supply is flashy, and not of uniform delivery, you frequently use a larger amount of water in the irrigation during high times if you have a soil where you can get storage than you would if you had a continuous flow during the whole season.

The Class 5 land (in the Yakima Valley) which has been referred to as giving some indication of an amount that is greater than I think this land needs, that soil type takes the water very rapidly. I have in mind one instance where I checked very carefully where a farmer was irrigating. He had water running down corrugations; these corrugations were well cleaned out; the water was delivered from a flume. It was running in these corrugations in as big a head as they would hold. He told me the water had been on there for five hours.

I paced the distance, and the water was at that time sixty feet from the flume. It was completely cross-subbed to the top between the furrows.

This Class 3 land we have here, I was told—have gained the impression by talking to a number of the farmers, I should say—that they can run the water through in two to three hundred feet, in their ordinary practice, practically in three hours; that if they wished to use a big head and force the water through, they can run it through in a shorter time.

That gives a comparison of the rates of percolation between those two soils (997).

I would say that this No. 3 soil does not have any unusual soil percolation problems, just from the standpoint of percolation during a single irrigation. It is undoubtedly possible by keeping the waters on a long time to lose an enormous amount through deep percolation, because there is nothing below to stop them. But in the ordinary irrigation practice it can be irrigated with very little percolation losses, in my opinion.

Crop yields are not proportional to the amount of water applied in such crops as alfalfa. The crop yields are frequently increased with increase in water to rather large amounts, but not proportional. There is a point where added water will not give an increase in yield in proportion to the cost, the amount of labor required to apply it. I would not say from the standpoint of the individual irrigation that there was necessarily a point where the increased water would decrease the yield of that particular crop.

I don't believe that the percolation on each side of the furrow will reach out farther in a sandy soil than it will in this No. 3 here, if the No. 3 is in good tilth; I believe this soil will cross-sub quite readily.

The total amount of water per unit of soil held in a sandy soil might be greater than this. But it is difficult to tell, because there is such a variation of sandy soil. The water-holding capacity on the basis of Mr. Larson's figures which he has introduced for this soil is considerably higher than a great many sandy soils.

I considered the evaporation losses of the Milton-Freewater (lands) as well as I could. I would see no

reason to believe that the evaporation losses up there needed to be unusual; however, I don't claim to have any regular data on that subject. I did not examine the data book (Washington Exhibit 18) in detail. I looked for the tables giving the relative humidity and evaporation in and near Walla Walla in the weather records which I have here, but I didn't find them in these records.

The July evaporation in 1932 of 10.617 inches, and in 1933 of 11.335 inches, shown on page number 2 of Washington Exhibit 18, is not necessarily larger than I considered. I have simply considered the evaporation as a relative proposition. I have not attempted to put any definite figure on the evaporation from the Freewater surface.

E. C. BURLINGAME, for the State of Oregon, testified in part (458-509):

Upon statement of counsel for the State of Oregon that the testimony of this witness was being offered to attack the validity of the priority of the right of the Gardena Farms District, the State of Washington interposed the following objection (459):

"The Washington decree, being Washington Exhibit No. 11, the general official map, being Washington Exhibit No. 17, the stipulations on file, and the testimony so far taken show that the Gardena appropriation from the Walla Walla River in Washington is Claim No. 570 of the Washington decree, by which decree the State of Washington recognized and established the appropriation of the Walla Walla Irrigation Company as a vested nd accrued right in said company to a priority dated 1892 and issued a certificate of water right to said company further evidencing the same; that the Gardena Farms District No. 13 has succeeded to all the rights of

the Walla Walla Irrigation Company recognized and established by said decree and said certificate of water rights; that the Walla Walla River is an innavigable interstate stream flowing within the boundaries of the two states involved in this action, and under the facts and the laws of Congress the State of Oregon cannot in this controversy in this court question the validity of the Gardena appropriation or its priority date, and the State of Washington objects to the introduction of any evidence to that end as not being material or relevant to the issues involved herein."

THE SPECIAL MASTER: Of course, the Court would have some trouble—I think the objection is properly in the record at this time, but I cannot pass upon the testimony until I hear what it is about—it is anticipatory—but the testimony of this witness as addressed to the subject indicated by Mr. Paul will be received subject to the objection and he need not repeat the objection as the testimony is offered.

The witness resumed (460):

In 1892 I came here to look over the survey of the Walla Walla Irrigation Company's canal and report to them on it. I took an engineer, instrument man, and two assistants and we drove to the intake of the survey and started to check their line. I had the map of the old survey with me in my hand, and I looked at the map and I saw that the survey went north, zigzagging around those rough hills toward the Whitman Monument and back in every direction until it came to within a few hundred feet of where I stood. That made me think that perhaps I could shortcut that survey, and I went back to the Little Walla Walla, and the engineers had just reached that point with their work.

I asked the engineer to drive a hub so as to hold his grade line and run the trial line over the saddle to me. He did so, and to my surprise in 1700 feet I found I was on top of the ground with the water grade of the ditch.

Then we went on a little further with the instrument, maybe a thousand feet or more, until we could get a full sweep of the country to the west, and we saw that there was a large valley, something like a section or more, that was all under the grade.

(462) I made my report to Mr. Boyer. They verified what I have just stated and asked me to become one of the company and to look after the building of the canal. Actual construction work was started in 1892 by a man with team and scraper and in a short time in that year I shipped in a grading outfit, put up my camps and went to work on the canal.

(473) I finished the Kennewick job in February, 1903. Prior to that time I had a map made and I had engineers make surveys. I had the old map. I had to have a survey go ahead on the line of construction before I could do the work.

(474) I had E. H. Guilland's map—that is the original survey. (Oregon Exhibit 33). I had been out over the line of the ditch as originally drawn upon that map. I had the survey made. I was there every little while. The line of dots beyond the letters "W. W. Irri. Co." has been added by somebody and was not made by the original engineer. When I originally had that map those dots were not there. The dotted line running down across the state line into Oregon southerly and westerly, then westerly and northerly and westerly clear over to the stream marked "Walla Walla River," on that map was

the original plan as furnished to me by the Walla Walla Irrigation Company before I became a member, with the exception of the change in the canal line west of the Little Walla Walla. Oregon Exhibit 34 is just simply a blueprint of the original survey. The proposed main canal was changed in 1903. The words and line in white ink on Oregon Exhibit 35 must have been drawn upon it after the original blueprint was made. I do not know who did it nor when it was done. Without those changes the blueprint (Oregon Exhibit 35) correctly delineates the original plan of the Walla Walla Irrigation Company canal. The present construction is about as outlined in the changes on the blueprint (Oregon Exhibit 35).

(482) I made the change in construction from the original blueprints to the present construction in about 1903. I discovered by looking over the land that we would leave what I considered the best portion of Gardena without water if we went ahead with our plans as originally made to build our ditch. They could not have been irrigated under the old main ditch as originally planned. The best lands are lands in the east end of Gardena on the highest altitude in Gardena covered by the pipe line. Two and a half or three sections of that land could not have been irrigated under the original plans.

(483) I think in the winter of 1903 or '04 we had decided that it would be best to cover that land and shorten the construction of the canal, and we figured that it would save water, get more land, that the land there would pay the cost of the construction of the pipe line.

(501) The west half of section 11, township 6 north, range 33 east is a mile lacking two to three hundred feet directly west of where the siphon empties into the Gardena canal in the southeast quarter of section 12, same township and range, which then flows west through the east half of section 11. Section 12 is the highest land in the Gardena plateau irrigated by gravity flow. A portion of section 11 is very little below that elevation; the north part is higher. On February 11, 1901, Elizabeth S. Burlingame, my wife, made a desert land entry on the west half of section 11. On January 4, 1893, I made a desert land entry on the same land.

(629) Washington Exhibit 36, showing the United States Land Office record of desert land entries on the west half of section 11-6-33 was admitted in evidence, as connected with the cross-examination of E. C. Burlingame, it being admitted by counsel in open court that Rhoda M. Burlingame, named in the exhibit, is the daughter of said E. C. Burlingame.

The witness resumed:

(504) I was a witness when the rights to the use of waters of the Walla Walla River were adjudicated in Washington. The Gardena right was contested by lower users on the river. Attorneys representing contestants cross-examined me rather thoroughly at that hearing.

(506) Before 1917 and since I have had control of the management of the Milton-Freewater and Hudson Bay Irrigation Company. I knew when their filing was from the river. I am farming a large acreage that is being watered now by that company.

WILLIAM FORSYTHE, for the State of Oregon, testified in part (525-542):

(529) I have four wells. The water rises in them in February or March. The rise continues a month or six weeks. In the summer time I have water very near the top of the well. It rises very near to the top in May and June. My wells average about 36 feet deep. The cement gravel in some places comes 10 to 12 feet from the top. Above that the soil is loose mixed up with rock and soil for the first foot or two.

(538) I dug the first well in 1896 or '7 and began then to use it for irrigation. I dug another well in 1906 or '7. The rise and fall in the first well has been about the same since it was dug. I get part of my water for irrigation from the Ford Branch. I had what they call a flood water right. I have my pumps on windlass platforms that have to be lowered a number of times during the summer as the water recedes in the well. That is true with all the wells I know of.

Elba Rogers, for the State of Oregon, testified in part (543-581):

(550) After they start to irrigate the water in the wells in my community will increase and later in the season when the evaporation is so great, it will decrease. I have a well 108 feet deep. I use it only when a short water year compels me to make up my water supply. The well is dug 38 feet and drilled the balance of the way. There will be somewhere from 7 to 10 feet of water in the dug well and after I start to pump it is only a small while until I am taking out of the drill hole. If I should cease to pump, it would take less than 2 or 3 hours until the eight-foot level in the dug part would refill. The diameter of the well is about 4 feet over. (577) I used it last 3 years ago. I can't recall when the well was sunk,

it was about 1912 or 1914, something like that, as near as I can remember.

(552) I have dug many a well. We start in at the top, and if you happen to start in a good place perhaps you will have a foot of soil, but as a rule it is gravel to start with, and that is generally from 8 to 12 feet thick before you strike what is called a cement gravel. As a general rule, after you get down 2 or 3 feet something like that, clear on down to the cement gravel, there is hardly any soil, it is porous. We have to curb that before we go any farther. There's places in that cement gravel that we call veins, that's full of water, but in the spring time the water stands up inside of our curb, which is from the floor on top of the cement gravel.

(557) I have five acres; three and one-half acres in tomatoes. The furrows run lengthwise about three feet apart. We cut that in two blocks about 19 rods long. We are on a three-day rotation. (564) I apply the water 24 hours out of each three days. (571) I get two other water heads besides my own. We have a head ditch across the upper part of the place and a cross lateral about the middle of the place. The water comes through this upper one, we will start in, say, on the east side, which is the higher side, we gather the water at the lower end of this other and irrigate on the west side with that tail water from the upper one. The tail water from the first eight ditches is run into the cross lateral below what we call the tail ditch and carried across to the further side of the patch. We irrigate from the center down with that. We irrigate about ten ditches at a time on the upper part and a half to a third as many on the lower part. (576) I believe I get my water from the west

branch of the Crockett. (566) The depth of the root of the tomato plant is about 10 inches below the surface to which the water is applied. The roots that go down that depth supply the vines. The roots closer to the surface, spread out, get the water and supply the fruit.

ALTA ROGERS, for the State of Oregon, testified in part (595-629):

(601) The first work done up at the divide of the Little Walla Walla to my recollection was along about 1890. That work was done every year from that time on down. In doing that work I would judge that about half the water was turned into the Little Walla Walla. We always left water enough run down there for East Side, and we merely guessed at it so as not to overdo the thing.

(601) I irrigate 15 acres. I have a main head ditch across the upper end of my ground, and my land lays—there's ten acres of the land that is 80 rods—80 rods running east and west and 20 rods north and south; and then I have five acres—my land lays in an L-shape—I have five acres that is 40 rods east and west and 20 rods north and south, and with my head ditch I have a lateral that comes out of the head ditch that covers every two tree spaces, which is eight ditches, and I take out of the head ditch into those laterals and run it through the eight ditches and catch it on the piece of ground north on the ten acres and use the tail water on that as much as possible so as not to waste any, and my laterals—or my ditches are just 20 rods long on the whole piece. I have water there for ten acres out of the creek and then I run a 2-inch pump. I rotate with the man above me, who has 5 acres. He gets it 2 days and I get it 5. I have a well six foot square 43 feet deep. Water seeps through veins

in the cement gravel. When I went on the place in 1913, the well 20 foot deep was there. I started in to deepen that well about 1916, 1917 and 1918. I had to deepen it several times. In the spring when they start irrigating the water will raise in the well up to the curb, within ten foot of the top of the ground. In the winter it is dry. (616) After they start the irrigation my well rises rapidly. The water comes on top of the cement gravel as near as I can tell, because it will run clear up to the curb in the loose gravel. It starts in at the bottom of the well. It is bound to start in on that, where it starts in and comes out. After it starts raising from the bottom it will come in and run down on the walls until you can't get down to the bottom; you have got to cover your pump up with something to keep from ruining your motor. (610) I mix my pumped water with my creek water to make me a better head, so I can get over my ground. The inch and a half per acre, combined with the water I get from my neighbor is not a big enough head to irrigate my land during the irrigation period. I run 4 rills between each row of trees which are 25 feet apart, two rills on each side. The first rill is 2½ feet from the tree. I used to run 5 rills but my water was so short through July and August, I had to cut it down to two on each side and cut out my center ditch (rill). I try to run 8 rills at a time. (620) During July and August I would say that maybe the majority of the time I get two-thirds of my amount of creek water.

(618) The water flows through this connecting channel between the Crockett and East Little Walla Walla during the fall, winter and spring. It is only during the dry season that this channel goes dry. That is also true

of this so-called connecting channel between the Ford branch and the West Little Walla Walla during the fall, winter and spring, water runs continuously down through there but during the dry part of the irrigation season that part of the channel is dry.

WARREN ROEDER, for the State of Oregon, testified in part (636-677):

I was assistant water master from the spring of 1913 to 1919 in charge of the distribution of water on the Walla Walla stream in Oregon.

(639) From the line between sections 25, 36, 35, 26, 27, and 34, township 6 north, 35, on down there was practically no channels in 1919. They were in places a foot and a half, they would narrow down to a foot and a half; there was willows, alders and brush all the way from 4 feet to 20 feet aside of the streams, these channels that went down. All the channels had a reach that was dry in the summer. The Crockett; the Ford—all the irrigation channels that we diverted water into; we dried up the Tum-a-lum, and all the channels that we run water down into were all dry at the end. No water during the summer time would go down either the Ford or Crockett branches to reach the State of Washington. (675) I wouldn't say some of it didn't get through during the year 1913; I would say it couldn't a whole lot get through. (640) The first year I was in, owing to the condition of the divides and the headgates, we spent the biggest part of our time taking the water down to the ends. The men at the ends would haul in loads of dirt and put across, manure and dirt, and put across those channels so that there was no water went below those adjudicated rights by the court. The water would come down to where those

channels narrowed down and then it would just flood out on the places. There was—the place that I had bought, finally bought, that was just a lake every winter and spring, owing to the fact that these channels were so small that the water couldn't get through. We straightened out the channels in various places, and their theory was that allowing this brush to grow on these creek channels saved the water, the evaporation, and, of course, naturally they didn't get any water down there to speak of in the summer because the fellows up above was taking all the water, and those channels were plenty wide enough to carry the little amount of water that would go down to the lower end of those branches. After we went on and got in the divides and proportioned the water so that the lower ranches would get more water, the ranchers immediately started opening up those channels and taking out that brush, they had to open up the channels, to get through to the channels so they could open them up. In some instances the channels were moved from the winding channel across their property to the border line, straightened out and enlarged three to four times as large.

(642) We put in the Frog at the lower end of the tail race of the Peacock Mill. It was a concrete divide high enough so that we could halt the water into the channels. The water is regulated into the channels with screw gates. The irrigator's water is measured to him on his place. (665) I said that this water was measured on the land. Wherever we run water from the creek to a man's place, if he didn't keep that creek cleaned out, why, we just cut down on his water and forced him to clean that ditch out. Whenever he had a good ditch, that we seen

was as good as he could fix it up, then we would take measurements at his place and allow the seepage necessary, but if he didn't attend to that ditch, why, we would just refuse to charge it up to the other water users and charged it up to him, so we forced the issue through.

(644) The first year Mr. Reineman (the water master) was located at Pendleton, and he would come up—he would notify me the days that he was coming up, and we would work on one stream and then switch over to—or one branch, and then we would switch over to the other branch and we would work on that for a day or two days at a time to determine. We cut the proportional weir, then we would go down and measure what each water user was getting and what amount of water was going through the main creek; then we had strips of galvanized iron about two feet wide, he would have his instrument with him, and we would level the bottom first and then we would measure what was going out to the water user and what was going down the main stream, then we would make a notation of the seepage and evaporation loss from the Frog down to that place, then we would take and work from that on down. The first year we spent practically two days of every week checking seepage and evaporation. The first year we added 15% to 25% for seepage and evaporation. In later years we changed that from 10% to 15%. We reduced our seepage and evaporation losses from 20% to 25% to 10% to 15%. The year I went off (1919) I put in the last main divide, what we called the Overturf divide.

(649) When we went on the divides—a water user would always see that the main creek was as tight as he could get it, but his headgate—we would have the weirs

in, but when I went on there, where they would tighten the main creek weir and see there was no seepage and leakage underneath them, they would never do that on their weir, so consequently some of them was getting as much water underneath and around their weirs or boxes as they was getting through the weir itself. When I went on the measuring devices were all wood. There was only one concrete headgate on the system, that was the Stillman headgate was on in concrete when I went on. All the rest was wood. Consequently the upper men were getting from an inch and a half to three inches of water, the lower ends were getting from half an inch to an inch, and all of the lower men, practically,—the biggest part of them, had wells, which they would use to get water sufficient enough to irrigate with.

(653) There are sections of my place that until the last two or three years I would turn a full ditch of water into one of the laterals and it would go down a part of the way and then it would just sink away. I would carry manure and dirt and throw in there, and get in with my boots and tramp back and forth until I would get that water going over that spot; then it would go down maybe two rods further, and have the same condition. I would work it down—maybe I would get two-thirds of the way down—understand, these laterals are none of them over twenty rods long—before I would get to the end of that twenty-rod lateral it would break out where I had got it over before, so I would have to go back up and work it down.

When I started irrigating it was just a matter of camping right with that water from the time I turned it into a number of laterals until I got it through, then I

would have to see that it went through. I irrigate 5 or 6 rows, a little over 3 feet apart, at a time in the cherry orchard, and 6 or 8 in the prune orchard in the low season. I cannot rotate with any person unless I would make my tail ditches and head ditches a great deal larger than what they are today. I haven't up to the present time used a well to supplement my supply. In 1933 I had a little over 2 miner's inches per acre in the last of March and the first of June. In the last of June 1½. In July it dropped below 1½ and in August it was just about up to the 1½ miner's inches again. My place is located on the West Prong of the Ford branch. The main Ford branch is east of this prong, which now runs around my place on the east side.

AUBREY E. PERRY, for the State of Oregon, testified in part (678-701, 853-861):

(685) I have made computations of seepage losses in the Ford Branch system taken from my report to the state engineer in the year 1918. The study down the Ford extends to the Charles Schwald place, 2 miles from the Frog. The total distance covered on both branches of the Ford was 4 miles. The study was made in July. At that time the farmers were diverting and all the water in the Ford Branch was being used for irrigation. The amount at the head was 18 c. f. s. The total loss in the 4 miles of the entire stream system was 32%, being an average main channel loss of 8% per mile. The method of determining that loss is to measure the amount of water flowing into the head over the head weir, then going along and measuring every diversion out of those channels, and then subtracting the amount that is being

diverted from the total at the head. That gives you your loss—actual loss.

(688) The various branches of the Crocketts run through the same kind of soil and the same territory. I do not have my figures upon either of the Crocketts. The only thing I have with me is what we call our weir cuts, figures on that, which show the total loss through there. Over a distance of 2 miles, the loss runs between 15% and 20% for the Crockett branches. The average would be close to 8% per mile.

(854) All the pumping operations from wells from which irrigation water is pumped are for irrigating the overlying lands owned by the owner of the well. (855) When the flow at gauging station 212, a half-mile below the forks of the river, is from 185 to 200 feet, and all the water in the river is being diverted between that point and the Hudson Bay intake, the Tum-a-lum is generally dry.

W. C. Mason, for the State of Oregon, testified in part (714-741, 1135-1146):

(714) From 1921 to and including 1933, I have been a water distributor or water master, in one capacity or another, on the stream (in Oregon). I am at present under James M. Spencer, district water master.

(715) We usually start regulating the distribution just as soon as the water becomes short, and the irrigators start in to making a general use. The years are different; usually some time in May or June, depending upon the season. We usually make pretty careful adjustments below what is known as the old West Bridge, approximately a mile below the forks. Above that I am

duly subject to call and have had only a few calls for any regulation up in that district; and I have made several investigations on complaint of other users as to the quantity of water used and its direct effect upon the stream system.

(716) I found that up to a reasonable use that the use of water by those irrigators above did not interfere with the general stream system. We did find that at the time they first made their diversions, we noticed a lag in the stream for a few days (three or four days), and have tried to encourage an earlier use so as not to catch that at the critical period in the lower district.

(722) I have observed the river as to freshets. I know in June, '27, we got one that came down within a 20-minute period, the river raised from 125 c. f. s. to 1000 c. f. s. The peak of that run-off was down by morning. (736) We are subject to the sudden rise and fall of the stream during May and June. When the snow on the mountains is hit by the warm winds, really hot days, hot weather, we have pretty heavy run-off. That run-off there on that water shed seems to culminate at about the same period. We get as high as a drop of twenty-five second-feet a day during the years, that is the general rule, along the later part of June, when that last run-off —when the melting snow seems to have ended we get those drops nearly every normal year.

(726) In controlling the water at the Frog for sending it down each of those branches to the water users, we have been allowing 15% to 20% for seepage. I refer to that as a general per cent of seepage. In the spring of the year when those streams are carrying heavier heads of water and the ground around the banks is full of

water from rains or winter snow there doesn't seem to be quite the loss that there is during the dry seasons and when the weirs are all in. The putting in of the weirs increases the loss in the stream. Owing to the stream system there, the fall in the land, and the individual water users taking water from the channel have to raise the channel, and especially the type of weir system we use, the overflow weir with clearance below the weir, sometimes making heads up between the streams on these gravel banks and the ground is usually dry along the banks, there seems to be a loss there. The putting in of those diversion dams or weirs in the channel of the stream reduces the carrying capacity of those stream channels. Of course, the lower parts on those streams, those streams being a system of their own there and the water being adjudicated to that particular section, we have practiced, and it has been practiced before I was on, putting in a system of proportionate weirs; owing to slight fluctuations in the stream it has been the most equitable distribution from that type, and they are rectangular contracted proportionate weirs, consequently, when you get down to the smaller tracts, or the tracts with the lesser number of acres on the lower reaches of the stream, your main weir boards will be cut sometimes fifty-fifty with the laterals where the irrigator diverts on to his land, and the stream with those weirs in would be, on the lower end, would be reduced probably fifty or seventy-five per cent of its carrying capacity.

(728) Most of the weirs were out in November and December, last fall (1933) when Dr. Woodburn made his test for seepage upon the Crocketts.

(735) The number of acres on the gravelly land that can reasonably rotate depends somewhat on the size of the tracts, of the individual tracts and the type of crop they have on the land. If they have just orchard land —we have some rotations as high as fifty to sixty acres that work out very nicely. Where they have tomato runs, seems like twenty-acre rotation system is about the most satisfactory.

(1135) I am required to make 160 diversions from the natural channels of the river for supplying Oregon rights.

(1136) We use proportional weirs upon these different channels.

(1138) If there is a surplus over the amount that the users are entitled to, it is proportioned among the users according to their rights for whatever length of time the surplus continues to run.

(1138) All of the rights, below that gravel fan and below the dry places upon the Ford and Crockett are supplied from springs during the irrigation season. They get some of the water, I believe, in the spring before the headgates are in. There's water feeds on there after the Peacock Mill Company has a right, and that water feeds on through before irrigation season is generally started.

(1138) When there is a surplus in the stream over all rights, I make no measurements to the users, as long as the rights are supplied.

(1141) In the event that there is an over-diversion into the Milton ditch and the water runs down past the end of it, it is picked up by the Finis Irrigation Company,

which irrigates approximately 107 acres down there with that waste water and the well.

(1143) When I am turning water into those natural channels such as the Ford and Crockett, I make an allowance of 20% for transportation loss. I allow 20% on the East Side Ditch for transportation loss. It is approximately 2½ miles over for the East Side users.

(1145) In regulating the stream for rights below Milton, I regulate the East Side Ditch and the Tum-a-lum Ditch and the diversion at the Red Bridge, and there's Stillman, Perkins, several other small users, along the Little Walla Walla, and the headgates at what is known as the Frog, and the Powell Ditch headgate, and the diversion weirs, and then the numerous small weirs up and down the East Crockett Branch and the West Crockett Branch and the Ford Branches.

ARTHUR M. PIPER, for the State of Oregon, testified in part (761-804):

(763) Washington Exhibit 16 is the report which I made upon ground water study of the Walla Walla River basin.

(764) Let me first go back to the form of the bedrock which underlies the basin and is the base upon which the valley is built. The outcrops of that bedrock are on the map (Plate 1, Washington Exhibit 16) colored green. They extend entirely along the north, closing around the west except a very narrow gap through which the stream escapes, continuously along the south. That rock is folded in the form of say a canoe-shaped basin, the deepest part of which is in the region between Touchet and Lowden and about on the state line. There that dense

bedrock as shown by the records of drilled wells is first reached somewhat below sea level and several hundred feet below the land surface. From that deepest portion the bedrock rises in all directions, so we have sort of a canoe-shaped depression. In that canoe-shaped depression of the bedrock we have various deposits, formations, laid down by streams, which make up altogether the valley proper, we might say.

(765) The oldest of those stream-laid deposits, or perhaps I better say water-laid, is delineated in the report as the deposits forming the Gardena terrace. On the map (Plate 1) they are discriminated by this orange color. In the southwest portion of the valley, where Gardena tracts are located, the terrace is approximately 125 feet above the flood plain of the Walla Walla River. As we come eastward the height of that terrace above the flood plain decreases. Opposite Milton it is perhaps 40 feet. As we come still further eastward and northward in the Mill Creek valley, it comes down nearly to the level of the flood plains. Initially that terrace covered the entire basin. It was a smooth, continuous plain. It comprises two fans in form; one with the center about the present canyon of the Walla Walla River at Milton. Another with its head near the present village of Tracy on Mill Creek. Those two fans declining westward, merged together in the vicinity of the place where the Yellowhawk now joins the Walla Walla River, in rather a flat, smooth plain, which continued across the rest of the basin.

(767) Mill Creek and the two heads of the Walla Walla have been the major streams, major headwater streams, of the basin for a long period, even prior to the

building of this plain. That plain in this upper part, the portions that are exposed, is built of relatively fine stratified material. That material is relatively fine, rather tight and would not transmit water rapidly. After the formation of that Gardena plain, the streams have cut into it, first cut down, and have formed the trenches through which the various streams now flow. Towards the heads of the two fans, that is, in the vicinity of Milton and Freewater and in the vicinity of the City of Walla Walla, the streams almost completely cut away the top of that old terrace. In a later stage they began to deposit gravel in the valleys which they had previously cut. The end product of that process has resulted in two formations distinguished on the map, one termed low terraces in the report, shown on the map (Plate 1, Washington Exhibit 16) by this brownish-yellow. Those terraces extend but little above the flood plain, nowhere, I would say, much more than twenty feet, and commonly five or ten feet, above the flood plains. They seem to be formed, also, of fine material, relatively water tight. Somewhat below those, and the youngest formation of the basin, is the coarse gravel forming the fans at the mouth of the canyon of the Walla Walla River and at the mouth of the canyon of Mill Creek, which extend outward as tongues, or fingers, perhaps, one along each of the streams, much like the pattern of one's hand, and separated by remnants of that high terrace which project in between. That gravel fan rests on and overrides the tips of these remnants of the higher terrace. That is the Gardena terrace. The flood plains which continue on down are built of similar material to the fans, but becoming progressively finer. That is the normal condition of a deposition by streams.

That briefly describes the three sedimentary formations which together form the valley floor.

(769) We have records of a number of drilled wells given in the report which give the total thickness of material resting on the bedrock. In well 551, B-2 (Plate 1) located in section 1-5-35 just south of the railroad crossing and just west of the river, owned by Milton Nursery Company, bedrock was encountered 348 feet below the flood plain. A well in section 8-6-35 labelled Q-1 on Plate 1 encountered bedrock at 175 feet. In a well owned by Shields Fruit Company in section 33-6-35 designated N-1 on Plate 1, bedrock was 413 feet below the surface. The well in section 31-6-36 designated on Plate 1 as K-1 encountered bedrock at 417 feet.

(774) In Plate 5, Washington Exhibit 16, we have shown the form of the water table at two periods, one approximately June 20th, 1933, and the other about August 29th, 1933, as the measurements upon which those lines were based were taken within a few days of those two dates, it being not feasible to cover every well in one day. The first period is that when the wells within a few miles of Milton and Freewater on the fan stood their highest for the season as we observed them last year, the latter period, August 29th, when they were about at this lowest point within that period, the lowest point following the peak of June.

The form is shown by contour lines drawn on the water table. For instance, the line here designated "750" is drawn along the water table so that everywhere it is 750 feet above sea level. The next line, designated "800" is so drawn that everywhere it rests on the water table

where it is 800 feet above sea level. That is 50 feet higher than the next contour to the west.

(778) That model (Oregon Exhibit 38) is of the same map as Plate 5, Washington Exhibit 16. I have taken the negative copy from which the prints of Plate No. 5 were prepared. I have divided it along each of its contour lines and pasted each portion on a thickness of heavy card so at each contour it steps up the thickness of the card, which you may take as representing the contour interval of fifty feet, so that the form of this relatively shows the form of the water table; if we imagine those rectangular steps are smoothed in. We can see from that where the contours are far apart, the grade between them is relatively gentle; where they are closer together, the grade is steeper.

The water in the gravel beneath the water table would move or percolate exactly as though it were surface water flowing down a hill of this form. In other words, it will move directly down the slopes. So on this map the ground water at any point is moving at a right angle to the contour line, and from the higher contour—the contour of higher number, towards the contour of lower number, designating the lower altitude.

If the gravel is of even texture throughout, the rate of movement is proportionally to the grade, or it is inversely proportional to the spacing between the contours. Where the contours are far apart the grade is gentle, the water is moving relatively slowly. If the contours should be half as far apart the grade would be twice as steep, the water would move twice as rapidly.

So the spacing of contours on the map and slopes

on the model indicate relatively the rates at which the ground water at the water table is percolating.

(779) The condition when the high water comes down so that there is water flowing on the surface in the stream bed for the full length of it, is represented by the period of our early contours, June 20th. That date was just as the spring freshet in the Walla Walla River, the Tum-a-lum fork, was declining.

At that time the contours of the Milton-Freewater fan are roughly circular, about a center up here—an apex in the vicinity of Milton.

The water table also rose both from the east and from the west in that distance, and was highest at the Tum-a-lum fork. If we take the grade of the water table between wells adjacent to the river and project that grade forward it indicates that the water table would very nearly meet the water surface of the river.

Records which we have taken on observation wells which we have measured frequently near the river rose and fell in a pattern which is entirely similar to the rise and fall of the stream, so we conclude that the ground water, when the river is continuous, that the water in the stream rises and falls as the river rises and falls.

Because those contours are circular, because of the model which I may hold in the same position, their form is roughly conical, the water which would seep away from the river and become ground water high on this fan could percolate radially outward directly down that slope over practically the entire width of that fan. In a conical form—rudely conical—water which left the river high on the fan in the vicinity of Milton and Freewater, if it per-

colated radially outward, could pass along the westermost edge of the fan, some of it nearly northward, some which would come directly down the slope would pass northwestward.

Within the limits of our mapping we did not have observation wells on the high terraces on Gardena terrace east of the river, so I do not know how far eastward that conical form extends. It does extend to the terrace where that rises from the gravel fan up to the Gardena terrace. So far as those measurements are concerned, it would be approximately symmetrical to both the east and west sides.

(781) From a point in the Tum-a-lum, approximately half way between the Nursery Bridge and the McCoy Bridge—that is between the 900 and 950 contour levels shown on the model (Oregon Exhibit 38)—water leaving the river northward would be more constrained as to the area within which it could percolate. It would be bounded by radii drawn through that point right down the two slopes at right angles to the contours. The area within which we would have free percolation would roughly include the drainage basin of the East Little Walla Walla and would extend westward nearly to the West Little Walla Walla. A radius starting at the Nursery Bridge and drawn at right angles to the contours would intersect the state line nearly at the west boundary of section 15-6-35, and the seepage would come in part within the area of the West Little Walla Walla.

(793) Along the higher part of the fan, the percolation of the ground water is unrestricted by these remnants of the Gardena terrace, but as we pass outward the

alluvial gravel separates into these several fingers which pass between and which rest on a floor of the material forming the Gardena terrace. In other words, our gravel, which relatively is highly permeable, is breaking up into tongues which are separated by relatively impermeable material. Those tongues rest on a floor of some relatively impermeable material which from below is narrowing the thickness of the young gravel. The net effect is to reduce greatly the area of cross section in that gravel through which the ground water can move freely. That is about three miles northward and westward from Milton, which would be along the tips, along the eastern tips, of those remnants of the Gardena terrace. There is perhaps about four miles of width in that gravel through which the ground water can percolate. A mile further out that width is reduced, aggregate width of those tongues, perhaps half that, so that it is constricted in width, with the greatest constrictions toward the west. As was pointed out earlier, those are the least distinct and narrowest channels and have the least of the young gravel fill.

(794) Just at Milton and Freewater the contours indicate a rather dispersion away from the stream. As you get farther north to the 800 contour on the north, the 800 contour and the lower contours have a similar form in that they trend somewhat west of north to the north of the Walla Walla River, but as they cross the river, (they) swerve sharply toward the west and southwest, so that on Plate 5 they have a general V-shape with the point of the V beneath the river. On the model a form analogous to a valley. If water is moving down the slopes, then, there it converges toward the river, both

from the north and from the south, along both sides of that valley.

(795) That would indicate that from the 950 contour about to the 800 contour, the stream is in general a losing stream. From the 800 contour (northward) the table slopes towards the stream from both sides so the water moving inward to the river (the stream) would tend to gain.

(785) The greatest fluctuations of the water table we have observed are in the district shown on the contour map (Plate 5, Oregon Exhibit 38). I wish, though, to make clear that this is not a depression in the sense that there is a continuous northward slope across it. It is not a cup-shaped hole in the water table. Because the water table is steep, because it rises 50 feet between those two contours, if it declines only half of that amount in between it is not sufficient to put a depression in there. There is a steepening of the gradient to the south, then a flattening, but nevertheless a continuous northward slope; then beyond that district is a steepening again. The gradient is not reversed so that the water is drawn back from the north. Its normal direction of motion is not reversed.

(789) Our observations have shown that the water table rises in some wells in response to the river, as I have just explained, in response to irrigation nearby, that is, the spreading of water over crop land near the well, and in response to rainfall, that those things will be reflected in some wells by the water table rising, that the water table will fall as pumping becomes general or as the river declines.

(790) None of our data would show the effect of evaporation and heat on the water table. The effect would be slight, would be obscured by so many factors it would be difficult to show. The natural regimen of the basin is such that more than one of these agencies causing the water table to fluctuate will be active at the same time. Irrigation naturally begins in the spring, when there is water available in the river, so that in the year 1933, as we have observed conditions, at about the same time the river was rising and wells nearby were rising with the river, water was being spread rather widely because of irrigation, and although in some of the wells we can detect portions of the fluctuations and relate them to the application of the irrigation water, it is impossible to say what fraction of the total rise is due to the river and what to irrigation. Conversely, on the decline, naturally the pumps are turned on as the supply available for surface irrigation declines, which is as the river declines, so that the depression of the water table due to pumping in 1933 began soon after the water table had begun to decline because the freshet had passed down the river. Our data does not justify an estimate of the portion of the total fluctuation that is due to these several causes, because the causes are working coincidentally. It is my judgment that the greater part of the fluctuation is related to changes in discharge of the river.

(792) At the time represented by our late contours this low point of the water table, perhaps, a slightly greater portion of the total movement was in the eastern half of the fan, say, slightly greater portion, than there had been at the early period. It would tend to divert—that is, if it were fifty per cent at the early period there

might be slightly more than that at the later period, because of greater steepening along the east side. That is a suggestion from the evidence we have. That to that extent would cause relatively more of a flow to the northward than to the westward.

(796) In our report which is Washington Exhibit 16, we list the springs which were found in the canvass made under my direction last summer, and we segregated those into three groups or three zones on the ground, so-called inner zone, which contains most of the springs, and which is roughly between the eight hundred foot and the eight hundred and fifty foot contours as drawn on Plate 5. The springs are arranged in a zone from half a mile to a mile wide, which is approximately circular. Beyond that there are fewer springs, arranged in what we call an intermediate zone, between the seven hundred and seven hundred and fifty foot contours on Plate 5, and in the outer zone, which is between the six hundred and six hundred and fifty foot contours, mostly the springs by far being in the inner and higher zone.

(797) In this valley my conclusion has been that the constrictions caused by the Gardena terrace remnant, the constriction of the permeable gravel has been so great that the groundwater under given conditions is not as free to percolate beyond that constriction as it is to the south of it. Therefore the constriction acts as a partial dam, retards the water, forces some of it to the surface, so it breaks out at the low points and forms these springs.

(797) The application of irrigation water is rather general over the whole fan. As I pointed out previously, our data did not permit saying what portion of the total

fluctuation of the water table is due to irrigation, although some of it undoubtedly is.

It has not been possible from the data now available to show that the form of the water table in any major feature is the result of irrigation or is the result of pumping. It is my judgment from that, therefore, that the general pattern of ground water circulation is a natural one, modified partly, perhaps, by irrigation water and by pumping, but not to a major extent. Our data does not permit saying to what extent.

(801) Figure 4, following page 67 of Washington Exhibit 16, is a profile showing the slope of the ground surface and also the slope of the water table at different periods. The diagram is drawn as though we could divide the country along the state highway extending northward from Freewater to the state line, removing the eastern portion and could look at it from the east. In other words, as we look at it, this would be a cross-section of the fan along the face of a north-south cut, viewed from the east side. The upper left-hand corner of Figure 4 is towards the head of the fan identified by well 552 B 1. That well is designated on Plate 5 as B 1 in section 2-5-35.

The springs discharge where the four profiles come nearly to the same altitude and where there has been little fluctuation in the water table somewhat below the 850 contour, slightly north, where the spring is designated by number 6523, P-12 on Figure 4.

(799) This stream system is spoken of in my report, Washington Exhibit 16, as a simple water table condition. The sources of water supply here are just the

drainage area in this Walla Walla Valley. Those springs that break out in the area beginning about 3 miles north of Freewater and extending on down to the state line along the Walla Walla River and in the lower Tum-a-lum are supplied by ground water. During the summer season, the ultimate source, so far as I know, of the stream flow in these spring branches from the springs to the north of Freewater and in the Walla Walla River at or in the vicinity of the interstate line, is the water from the drainage of the north and south fork, the main stream and small tributaries above, with the exception of a few artesian wells which do not enter the problem.

(800) There are no static waters confined under pressure in that water table. The springs are produced by the intersections of the water table and the surface. They are not the overflow of an underground reservoir of static water under pressure. With the exception of a few wells which are entirely through into bedrock, the primary source of which is not correlated to the primary source of the ground water, which we are discussing here, the tapping of the water stream, the underground stream, by wells, would be the tapping of a moving supply of water, however slowly it may move, it would be the tapping of a moving supply of water.

James M. Spencer, for the state of Oregon, testified in part (1147-1156):

(1148) I have made studies to determine the transportation loss in the main channel of the Tum-a-lum from the Red Bridge to the East Side Ditch Company's headgate below the railroad. Two current meter measurements I got 13.6% and 14% loss. In one case there was

15.4 c. f. s. in the stream at Red Bridge, the other there was 13.24 c. f. s.

(1154) I made one of those measurements July 11, 1930; the other July 13, 1932. Water was being diverted between the two points at the time I made the measurements. On July 11, 1930, I metered the stream at the Red Bridge, 13.24 second-feet.

I metered the Cemetery diversion, that is, the pumping plant, one and one-quarter second-feet.

I metered then below—there was a swimming pool in there;—part of my study was to see whether that swimming pool was losing water—I metered below that; I had thirteen second-feet after that other delivery had gone out. At that time there was evidence of some seepage back from Little Walla Walla; probably off-set the pumping plant of the cemetery.

Then I measured the Tum-a-lum delivery—the nursery was not pumping at that time,—and the East Side delivery, and there was a loss of 1.8 second-feet between the point where I measured last and the final delivery to those two channels. There was no other delivery between there.

July 13, 1932, I metered the Tum-a-lum, 15.4 second-feet; the Tum-a-lum ditch, 2.3 second-feet; the East Side, 10 second-feet. The Miller Nursery was pumping 1 second-foot. 13.3 second-feet; loss 2.1. I do not have the amount of the diversion at the Red Bridge through the Little Walla Walla at the time of the measurements; the bulk of the water was in the Little Walla Walla; that was a very small part of the water in the river. I can't say certainly whether the Hudson Bay was diverting any water at the time of the measurements. I think not.

(1149) During the time I have been here I have ascertained what amount it is necessary to turn down in those various natural channels in order to carry to the diverters from those channels the amount of water decreed them. We have done it in a rather cut and try method. We have determined it runs from 17% to 20% to the East Crockett. I think it has gone as high as 22%.

Ed K. Humphrey, for the State of Oregon, testified in part (862-884; 887-893; 1157-1170):

(867) I have made a study of the comparative flow as to the time of the rise and fall of the Walla Walla River and of Mill Creek. There seems to be a direct relation in the fluctuations of those two streams. We have actual measurements of Mill Creek (Washington Exhibit 19) plotted on the graphs (in Oregon Exhibit 41) for the years 1914, 1915 and 1916. The comparison is between Mill Creek and the South Fork only. That is the only record available for the two streams. But they show a very distinct and evident relation between the flow of the two streams over those periods.

(874) In my table on the fifth page from the last (of Oregon Exhibit 42), based on measurements of the Gardena canal in the year 1932 shown in Washington Exhibit 18, I allowed 12.7% loss in the canal from the river to the project for the year 1933. The volumes of water in the canal were substantially the same for the two years.

(880) The total power bill of the users of wells for irrigation from the Pacific Power and Light Company for 1932 was $11,789.32 and from the Milton City power for 1931 was $3,710.47. These are the only two sources of power for the operation of wells by electrical energy.

(888) With the exception of the pages entitled, first, "1932 Use of Water from Wells;" second "Pumping Equipment Efficiency Data," and (third) "Table Showing Per Acre Delivery Amounts Based on the Preceding Figures and the Flow in the Gardena Canal," the datum in Oregon Exhibit 42 relates to the test places listed on page 1 (of the exhibit). The soil classification on page 1 of the exhibit under column entitled "Soil Class," is taken from Youngs' map (Washington Exhibit 15).

(892) I will read into the record a list of the pages of the Oregon decree (Washington Exhibit 1) on which the several rights of these test places are found:

The Charles Eiffert place, page 116.

John Gunn (Knopf) place, page 130.

Hermann place, page 138.

Herr place, page 139.

Karker (Corkery) place, pages 149, 109.

Roeder place, page 216.

The Babcock and Harris places take water from the West Prong and the Bookout ranch takes water under a permit on the Pleasant View Ditch.

(1166) On Oregon Exhibit 44, under the word "Channel," I have a list of names which refer partly to natural channels and partly to ditches. As I understand it, the Stillman, Milton, Powell, Perkins and the Tum-a-lum are all ditches. The measuring point is at the most convenient location on the ditch. The West Crockett, East Crockett, Ford and the East Side Ditch are all natural streams, so far as our decree is concerned, and the measuring points (for them) are the points of diversion of each individual landowner.

WILBUR L. POWERS, for the State of Oregon, testified in part (1002-1036, 1127-1132, 1171):

(1013) The term "usable water capacity" would include the moisture stored in the soil between the point of permanent wilting, or just above it, as the lower limit, and the moisture equivalent approximating the higher field samples moisture contents that you would find by the time the soil was dry enough to mulch or seed,—you have had the water present long enough to be in equilibrium with the soluble material in a solid phase, so it would really be of nutrient value to the plant. The usable water capacity for fine sand is about one inch, about the coarsest sand we irrigate. On the other end it is only the heavier soils that will hold more than two inches and a half usable water.

(1016) Most of the storage capacity in this No. 3 soil of the Milton fan is in the first 2 feet and is on the order of two or two and a half inches. I would say the usable soil would be largely within the first two feet, some value in the third foot. For good growth rate, we should have usable moisture in the major part of the feeding root zone.

(1020) It would be difficult to apply much less than a five inch irrigation upon this No. 3 land, and perhaps two and a half to three inches of it might be retained.

(1021) Assuming the application of 5 acre-inches for each irrigation, it would take a head of one and a half inches to the acre, continuous flow to go over the No. 3 land, for the critical months.

(1025) In the surface soil in the No. 3 area around the Milton-Freewater territory, there has been heavy

manuring and disking in of alfalfa, and the organic content is rather good, and in the sub-soil there isn't so much. The first 6 inches to plow depth our test indicated on the order of 5 to 6 per cent organic matter.

(1028) Tree crops on the No. 3 lands, in my judgment, should be irrigated about once a week. Tomatoes, apparently, must be irrigated at least twice a week to prevent wilting.

(1029) The amount of water I have suggested, one and one-half miner's inches, continuous flow, is rather an unusual amount of water for irrigation and for a very unusual soil. These unusual conditions are the limited, very limited, usable water capacity and no ground water within a distance that will help meet the situation for the roots, and a long, relatively hot growing season, and intensive farming.

(1030) The period of dry years (we have had) has entered into my determination of the amount of water these people should have, only in a general way.

(1030) Early in the season from the dust carried by wind, the water may coat over and penetration along the furrows in the No. 3 soil may be a little slow. The organic matter aids the penetration and also the lateral spread of water applied, I think. The spread would not be good as long as it was open below. There is nothing unusual in that soil between the rocks that would require more water than we would require in soil of that texture anywhere (but) the rocks hold nothing or practically nothing. If they constitute three-quarters or two-thirds of the volume, then your reservoir is very limited.

(1034) I have only spoken here of farm duty, to the farm unit or headgate.

(1128) The colloid fraction of the soil includes the extremely fine particles, both organic and inorganic. Roughly, or in plain words, we say clay jelly and peat jelly or humid jelly. It increases with the fineness of the soil. Normally there is much more in the heavier soils that are higher in clay content.

(1133) I think the soil marked orange on Washington Exhibit 15 just north of the Mill Creek would be even more droughty than the soil marked orange near Milton. It is practically waste land, having gravel pits and dumps, and most of it is unleveled and dry. I think that is extremely coarse in there, a quarter section or so. With that exception, I think the No. 3 lands on the Mill Creek area would have in a rough way the same water requirement as the No. 3 lands on the Walla Walla.

F. A. FULLERTON, for the State of Oregon, testified in part (1037-1041):

(1037) I am business manager of the City of Milton. Our meter records show a consumption of 2 million gallons of water a day in the months of January, February, March and April, and in the summer months of 3 to 3½ million gallons a day. The peak of that use is in the month of August.

(1039) None of our users are metered. These figures I am giving are on our total meter that we have before our water is sold out to the water patrons. It is the main line meter on our system, and measures all the water that goes into our mains.

(1040) This water is used for household use, for lawns only and small garden plots. The regular charge is $1.50 a month and in the summer time we have a

sprinkling charge, a minimum of 35 cents and 70 cents a hundred square yards for the number of square yards the consumer has to sprinkle.

S. T. HARDING, for the State of Oregon, testified in part (1043-1098):

(1046) I arrived here on March 29th and have spent the time from then to the present (April 5th) in field observations, going over the material collected for this case, the exhibits and testimony and other records.

(1055) The rate of seepage loss varies with the character of the material in which the channel is constructed, and with the size of the channel itself. The percentage of loss per mile in the same class of material is materially higher in the smaller channels.

In ~~this a~~rea the flow of the river is divided into different prongs or channels which are natural in origin and which in the upper portion of the cone and the main portion of their lengths are in coarse material.

For the size of those channels which the records that I have examined indicate carry in a general way around twenty second-feet and the distances which they are used to deliver water to the individual rights on this area, I would consider a twenty per cent conveyance loss reasonable. That is, it would be about what one would expect to find with those channel conditions in those soils.

(1056) The natural channels come down the cone in general on the steepest grade, which is approximately one per cent. The first form turn-outs consequently take off at right angles, which is at a rather flat grade, and the furrows then run again on the steeper grade of the land.

Those farm ditches taking out on the flatter side grades apparently catch some of the silt that is in the water, the grass that grows in the ditch assists in that practice, and I noticed a number of the farm ditches recently cleaned in which little gravel was visible, the silt occupying most of the bed of the ditch.

(1062) I would assume that the stipulation of that period and the testimony of the landowners represents a reasonable result of their experience. That period is relatively short. It is shorter than the frequency I have found in other areas in soils except those of very heavy texture or shallow depth over impervious sub-soils. I have found lands on which it is necessary to irrigate as frequently as seven days where the soil is heavy clay, in which only two to two and a half inches of water can be made to absorb at an irrigation and which can't carry the crop for any long period of time.

I have also found that frequency used on shallow soils over impervious sub-soils where similarly limited moisture capacity occurred.

It is also occasionally found necessary to irrigate pasture crops of shallow rooted grass at relatively frequent intervals on soils of somewhat better texture, but for deep rooted crops, such as those mainly grown here, to which the seven-day period applies, that frequency is shorter than that found to be generally required in other areas. The soil itself is coarser than the soils of which I have found longer periods usable, and the seven days appears consistent with the ten to twelve or fourteen that are usual frequencies in areas of other coarse soils.

The seven days I mention applies to the tree crops with cover crop.

The record indicates that for tomatoes and shallow rooted crops even shorter frequencies are needed.

(1064) That soil is relatively coarse, contains a large percentage of gravel and rock fragments of larger size. The soil filling material, or the finer soils within the gravel, as indicated in the soil survey and as I have observed it, reaches from a medium to fairly light texture through which water would move readily, and I found from the information obtainable that they apparently use five to six inches depth of water for irrigation, which is about what I would expect to find necessary to use to get over these lands with the length of furrows and the methods employed.

(1065) These soils are clearly ones of limited moisture holding capacity. If the soils can only carry for a week's time from an irrigation, and five to six inches are applied at each application, obviously the difference must become a deep percolation through the land.

(1066) Evaporation will occur from the surface of the soil in the furrows. That should not be much in this case, due to the general shading of the cover crop. The transpiration of the cover crop to some extent balances the saving in that evaporation. The figure I have used of two to two and a half inches per week consumption of moisture would include evaporation from the surface of the soil as well as transpiration from the trees.

(1067) The necessary frequency of irrigation, my soil test experience in other places, with the transpiration of moisture in July and August, would indicate that 2 to

2½-acre inches of water is retained by the soil after each irrigation. If a five to six inch irrigation weekly is applied and we make some allowance for loss by seepage in farm ditches, the rate of flow required would work out closely to an inch and a half per acre continuous flow, using the Oregon value of the miner's inch.

(1070) In this area they use natural channels to a greater extent for conveyance of water than is customary in most areas, because of the natural condition of division of the water into various channels to distribute over this area.

(1078) The water supply of those more northerly lands (in Oregon) is affected, in my opinion, by the irrigation on the cone. The actual use of the water by the individual landowners is probably not affected. Those lands are Class 1-D and Class 4. Both of these classes are soils of better texture than the Class 3. They would not require as frequent irrigation or as large amounts of use. Both of these classes have water table within 6 feet of the surface. I have not attempted to make a detailed analysis of the reasonable requirements of the individual holdings within this area. It is, in my opinion, clearly less than that of the Class 3 lands, but an actual determination of *the reasonable use would involve* the consideration of the individual holdings, the variations in soil at the margins of the different soil classed, and other similar detailed information, which has not been available.

(1083) I would consider the present decree reasonable in regard to those lands, having in mind that it includes a provision that the rate of use specified is the

maximum rate permitted, and that actual use is limited by the requirements for beneficial application.

(1084) It was not my intention to say that the amount of the allowance in those decrees is tolerable because the decree provides that the amount awarded is the maximum and protects against excessive use by limiting the user to a beneficial use. The point I was making is that in my opinion the allowance of an inch and a half per acre is reasonable for the larger part of the gravel cone, but that within that area, not recognized by the decree but probably existing, one could find small areas where perhaps the land could be handled on a somewhat smaller allowance, but that the scattering of those areas and their extent is such that it is not feasible to distinguish them in the decree. I think the maximum allowance in the decree is itself a measure of the requirement of the lands for the main portion of those areas. The decree unless it goes into the definition of variable rights of use for each individual area, if it applies any uniform rate to a larger area should have that rate large enough or liberal enough to cover the requirements of the main portions of the coarser types.

(1090) It would not be my recommendation that a water requirement of one and one-half miner's inches be distributed to all the lands having rights under that decree. I said that if you are going to have a single value of water requirement under the decree that value must be large enough to include any substantial area within the total area. If you have only one limit it has to be the top limit, otherwise certain lands would not be able to get the water which they require.

I did testify that while the limit, except for the two large ditches, in this decree is stated as an inch and a half per acre, there are lands at the north end which do not require an inch and a half per acre and which it is my understanding are not supplied an inch and a half per acre at low water periods from the flow of the upper stream; they are limited to such water as is available from the springs.

(1087) The silt content of the flow that comes through the branches below the Frog would be higher at flood stages. I haven't examined the stream at flood stages and do not know to what extent it may carry silt. The water now flowing is reasonably clear. Most of the natural channels have a steep grade and the gravel is exposed in their bed. I did note occasional places where a stream channel has taken a turn where velocity is checked where a silt berm has formed in the bend. I have stated that where the diversion channel took out at right angles to the stream I found the diversion well silted. That came from the main stream, but in the main stream, which is in most of its length of steeper grade, the silt would tend to be carried through, except where the water is checked.

GEORGE N. CARTER, for the State of Oregon, testified in part (1099-1125):

(1107) I came here March 25th, and ever since then have been quite industriously engaged in the study either of field conditions or of the various records which are available for consideration of this project.

Irrigation practice in general in the Walla Walla valley seems to be quite in conformity to the methods

and systems used in other places with which I am more familiar. The method of distribution of water is quite common, and I think well-accepted practice. And in general I would say that conditions, with the exception of soils, are fairly similar to other areas with which I am acquainted.

(1109) It appears that the minimum amount of water which can be applied to these lands in one irrigation is five or six inches in depth. That also checks my experience elsewhere. I have observed that generally speaking five or six inches is about a minimum application under average farm conditions, that application being a minimum of five or six inches, then the frequency will determine the amount of water necessary during any period of time, a month, or the irrigation season.

(1111) Taking the nine test places, the average use of water during the month of July was 2.52 acre-feet per acre.

During the month of August it was 2.09 acre-feet per acre.

Making a mean for the months of July and August of 2.3 acre-feet per acre, which, converted to continuous flow, amounts to 1.49 miner's inches per acre.

I said that I took the nine places. I eliminated the Bookout place, on account of the fact that its soil is not representative or similar to the other places, which were largely gravel lands or lands approaching the gravel. It would have been impossible to have gotten a July record. As I recall, that right shut off on about the 4th day of July.

(1117) The use record, in my opinion, is of con-

siderably more value than any other information at hand. It has been my experience with irrigation farmers, where they are working under conditions of limited water supply and are attempting and succeeding in applying reasonable methods, that their conclusion or ideas as to the amount of water available during a season are the most reliable guide. I think there is probably a tendency on one side to approach a theoretical minimum, which may be opposed on the other side by poor or haphazard irrigation farming or just use of water. The problem as I see it is to reach a reasonable meeting ground between these two extremes. At least that is the theory that I have pursued in my irrigation work.

(1117) In fixing the duty of water for No. 3 soils, including the 2-B, at an inch and a half per acre, I feel that is a reasonable meeting point between those two extremes for this district. I do not have in mind any case of extreme use in this district beyond one and a half miner's inches. I was just stating the problem generally, that that is the problem. There may be cases in this valley where more water is used, but I don't know of them. That is frequently the case in any irrigation project, that there will be a few farmers who either will attempt to use more water or else they will succeed less with the same amount of water as their neighbor.

(1123) I find no saving appliances up in that territory more than well-constructed channels, which confine the water as much as possible—good, concrete control gates, turn-outs, where rather rapid adjustments can be made of the supplies, the water is not spread out all over

the country and running wild, anything like that. It is pretty well controlled, I think.

(1124) My understanding is that a number of those rights with fairly good priorities on the river still pump to augment their supply. Many of them also have later rights which cannot be used in the summer time from the stream.

Conclusion of the Testimony

Both parties having rested, the following took place (1193-1195):

The Special Master: Let the record show that both sides in this case have rested.

What time do counsel desire for the preparation and filing of the briefs?

The order will be that the State of Washington shall have 60 days from this date (April 6, 1934) within which to prepare, serve and file its brief. The State of Oregon may have from the date of such service of the Washington brief upon it, a period of 60 days within which to prepare, serve and file its brief. The State of Washington may have an additional 15 days within which to file a reply brief if it is so advised.

Upon the application of either party and upon good cause shown, oral argument may be had after the briefs are filed at such time and place as may be fixed by the Master.

The case will now be submitted, as far as testimony is concerned, and the Court will stand adjourned.

EXHIBITS

List of All Exhibits Received in Evidence

(Numerals in parenthesis refer to page of reporter's transcript of testimony where submission of exhibit in evidence is shown)

Washington Exhibit 1.	(9)	Oregon Decree on Mandate involving Walla Walla River.
Washington Exhibit 2.	(10)	Oregon Decree and Findings involving Pine Creek.
Washington Exhibit 3.	(10)	Oregon Decree. Findings and Supplemental Findings involving Middle Branch of Mud Creek.
Washington Exhibit 4.	(10)	Oregon Decree and Findings involving East Branch of Mud Creek.
Washington Exhibit 5.	(10)	Oregon Decree and Findings involving Dugger Creek.
Washington Exhibit 6.	(10)	Oregon Decree and Findings involving Goodmans' Spring Branch.
Washington Exhibit 7.	(10)	Oregon Decree and Findings involving Johnson Creek.
Washington Exhibit 8.	(10)	Oregon Decree and Findings involving South Branch of Mud Creek.
Washington Exhibit 9.	(11)	Oregon Decree and Findings involving West Prong of Little Walla Walla River.
Washington Exhibit 10.	(12)	Tabulation of Oregon Permits.
Washington Exhibit 11.	(12)	Washington Decree and Referee's Report involving Walla Walla River.
Washington Exhibit 12.	(12)	Washington Decree, Decree on Remittitur, Referee's Report and Supplemental Report involving Doan Creek.
Washington Exhibit 13.	(12)	Washington Decree, Order Modifying Decree, Referee's Report and Supplemental Report involving Stone Creek.
Washington Exhibit 14.	(12)	Tabulation of Washington Permits.
Washington Exhibit 15.	(12, 896)	F. O. Youngs' Soil Map.

Washington Exhibit 16.	(14)	Ground Water Report by Arthur M. Piper in 2 Volumes, including 2 Plates.
Washington Exhibit 17.	(15)	General Official Map of Walla Walla Basin.
Washington Exhibit 18.	(16, 254)	Hydrographic Data of Walla Walla River System—bound volume.
Washington Exhibit 19.	(16, 454)	Supplemental Hydrographic Data—Walla Walla River.
Washington Exhibit 20.	(18)	Tabulation (by sections) of estimated irrigated acreages of related lands in *Washington* under soil classifications shown on Youngs' soil map.
Washington Exhibit 21.	(19)	Tabulation (by sections) Same—as to lands in *Oregon*.
Washington Exhibit 22.	(19)	Tabulation (by priorities) of estimated irrigated acreages of related lands in *Washington* under soil classifications shown on Youngs' soil map.
Washington Exhibit 23.	(19, 159)	Tabulation (by priorities) Same—as to lands in *Oregon*.
Washington Exhibit 24.	(56)	Telegram—Bartholet to Luper (10 words).
Washington Exhibit 25.	(56)	Telegram—Bartholet to Luper.
Washington Exhibit 26.	(56)	Telegram—Luper to Bartholet.
Washington Exhibit 27.	(126)	Tabulation of Administration of Stream System in Washington by Harlow Barney, Water Master.
Washington Exhibit 28.	(309)	Abstract of Oregon Well Permits.
Washington Exhibit 29.	(309, 311)	Tabulation—Wells in related area in Oregon.
Washington Exhibit 30.	(453)	Tables Nos. I, II, IIa, III, IV, IVa, V, VI, VIa, VIb, and VII showing engineering studies of the Walla Walla River by James G. Woodburn.
Oregon Exhibit 31.	(455)	Finis Decree.
Oregon Exhibit 32.	(457)	Names of Oregon Water Masters with official record of their respective appointments.
Oregon Exhibit 33.	(474, 459)	Tracing of survey lines of canals—involving right of Gardena Farms District.

Oregon Exhibit 34.	(477)	Blue print of tracing of old survey of line of main canal—involving right of Gardena Farms District.
Oregon Exhibit 35.	(479)	Blue Print of Orgeon Exhibit 33 as it is alleged to have been before altered.
Washington Exhibit 36.	(629)	United States Land Office Record involving W½ of Section 11-6-33.
Oregon Exhibit 37.	(704)	Map of recent survey of old survey of line of canal and designation of area above elevation of old survey, involving right of Gardena Farms District.
Oregon Exhibit 38.	(792, 807)	Model — Relief Map — by Arthur M. Piper.
Oregon Exhibit 39.	(853)	Tabulation of acreage above elevation of old survey of line of canal shown in Exhibit 37, involving right of Gardena Farms District.
Oregon Exhibit 40.	(864)	Map of plane table survey of irrigated acreage of Gardena Farms District.
Oregon Exhibit 41.	(865, 888)	Hydrographs of data in Exhibits 18 and 19.
Oregon Exhibit 42.	(868, 893)	Hydrographic data and measurements submitted with the testimony of Ed. K. Humphrey.
Oregon Exhibit 43.	(1015)	Graph of Dr. Powers—Water holding capacity of soils.
Oregon Exhibit 44.	(1157, 1162)	Analysis of alleged over-diversions in Oregon—1933.
Oregon Exhibit 45.	(1172)	Bridges in Oregon and Washington, their names and respective locations.
Washington Exhibit 46.	(1178)	Mechanical analysis — Mill Creek gravelly loam—fine earth.
Washington Exhibit 47.	(1189)	Tabulation—Dr. Woodburn—Flow at various points of Walla Walla River in c. f. s.—June, Oct., Nov., Dec., 1933.

OBJECTIONS TO EXHIBITS

The exhibits above listed were received in evidence. All were submitted without objection with the following exceptions, which are referred to by number with a statement of the record as to the objection applicable thereto set forth following each respectively (numerals in parentheses refer to page of reporter's transcript).

WASHINGTON EXHIBIT 15

In connection with the soil map prepared by F. O. Youngs which was introduced in evidence as Washington Exhibit 15, it was agreed by counsel in open court (12) that Mr. Youngs prepared this map after an examination of the territory in question being personally upon the ground, that this was prepared by cooperative arrangement between the State of Oregon and the State of Washington, and that Mr. Youngs' qualifications are as follows:

(896) F. O. Youngs received the degree of B. S. in agriculture from the State University of Idaho in 1921; spent the summers of 1920 and 1921 on soil survey work for the State University of Idaho. He has had three years practical farm experience. From the year 1922 to date he has been with the Bureau of Chemistry and Soils, United States Department of Agriculture, and at all times from the period of the soil surveys of the lands classified set out in the simplified soil map, Washington Exhibit 15, Mr. Youngs was and now is Assistant Soil Surveyor with said Bureau in the United States Department of Agriculture.

WASHINGTON EXHIBITS 20-23

(17-20) These exhibits contain estimates of the acreages of the various areas classified on F. O. Youngs' soil map (Washington Exhibit 15) according to type of soil; Exhibit 20 being a tabulation by sections of the estimated acreages of the related lands in the State of Washington; Exhibit 21 being a tabulation containing the same information for lands in the State of Oregon; Exhibit 22 being a tabulation by priorities of the rights on estimated acreages of the related lands in the State of Washington; and Exhibit 23 being a tabulation containing the same information for lands in the State of Oregon.

Upon submission of these exhibits in evidence, the following took place (19):

(19) MR. COCHRAN: We object to them as being a mere estimate, and it does not show what would be the governing classification of any particular man's water right, and it is impossible from maps and decrees to so make that acreage so as to delineate just what would be any particular year or any particular priority.

THE SPECIAL MASTER: You admit the qualifications of Mr. Chase?

MR. COCHRAN: Yes, we admit the qualifications of Mr. Chase.

THE SPECIAL MASTER: You admit the competency of the datum from which he took these surveys? For instance, Mr. Cunningham states that he perimetered around upon a map. The court does not know what map. Counsel may know what map—

MR. CUNNINGHAM: For the record I might state Mr. Young's soil map.

THE SPECIAL MASTER: Without an examination the court can not fix a value upon thi. testimony, and will say that counsel may protect themselves upon these exhibits pretty fully by cross-examination if they want to. They will be admitted subject to motion to strike after counsel for the State of Oregon have examined them, and will be able to point out to the court whether or not they do contain valuable information in the adjudication of this matter, but if there is no motion to strike the exhibits will remain in the record for what they are worth.

(159) MR. COCHRAN: We do not deny the section or the type of soil, but simply the present exhibit, and by reason of the fact it is impossible to arrive at a correct acreage distribution according to priorities, we move to strike out the Exhibit 23, I think it is, which is the tabulation by priorities.

THE SPECIAL MASTER: The motion will be noted and ruled upon after examination.

WASHINGTON EXHIBIT 29

(310) MR. CUNNINGHAM: We are offering in evidence at this time Washington's Exhibit No. 29, being a tabulation of approximately 80 per cent of the wells in the related territory in Oregon. The datum in this tabulation has been secured through inquiry that is based upon hearsay. Copies of this tabulation have been in the hands of opposing counsel.

THE SPECIAL MASTER: Any objection to the competency or the relevancy of this testimony?

MR. COCHRAN: We object to the materiality and the relevancy of it on the ground that the wells in question apply to the use of percolating waters which belong to the landowner and over waters concerning which this court would have no jurisdiction and the use of which is in no way connected with the use of the surface waters and the stream flow of the stream.

(311) THE SPECIAL MASTER: The objection will be noted.

OREGON EXHIBIT 31

(455) MR. COCHRAN: I would like at this time to introduce in evidence the findings of fact, conclusions of law and decree in the Circuit Court, and decree upon the mandate from the Supreme Court of the State of Oregon as entered in the records of the Circuit Court of the State of Oregon for Umatilla County in the case of Little Walla Walla River Irrigation Union and others versus Finis Irrigation Company and others, final decree made and entered in the Supreme Court of the State of Oregon on October 5, 1912.

MR. CUNNINGHAM: I would like to have the record show the State of Washington objects to the introduction of this decree in evidence as being immaterial and not relevant to any issue in this case. Our understanding is that the rights involved in this decree were all adjudicated in the decree and contained in the decree of the Circuit Court of May 16th, being Washington's Exhibit No. 1, and that the Exhibit No. 1 supersedes any rights adjudicated in this decree.

THE SPECIAL MASTER: Do you object, Mr. Cunning-

ham, to the competency,—that is, that this is not an exemplified copy?

MR. CUNNINGHAM: There is no objection to the form of the decree.

THE SPECIAL MASTER: You just object to the materiality?

MR. CUNNINGHAM: The materiality.

MR. COCHRAN: It is our contention that while the Exhibit 1 is based upon this decree and includes a great deal more land than this decree includes, yet it is our position that with the beginning of that decree we began the distribution of water in 1912 and it is to show the taking charge of the distribution of water and separate distribution from that time on as a separate stream system in Oregon, and also is one of the items in adverse possession.

THE SPECIAL MASTER: The objection will be noted, and the exhibit may be received.

OREGON EXHIBITS 33, 34, 35, 37, 39 AND 40

These exhibits relate to the right of the Gardena Farms District.

(459) MR. PAUL: I would like to state an objection at this time. The Washington decree, being Washington Exhibit No. 11, the general official map, being Washington Exhibit No. 17, the stipulations on file, and the testimony so far taken show that the Gardena appropriation from the Walla Walla River in Washington is Claim No. 570 of the Washington decree, by which decree the State of Washington recognized and established the appropriation of the Walla Walla Irrigation Company as a vested

and accrued right in said company to a priority dated 1892 and issued a certificate of water right to said company further evidencing the same; that the Gardena Farms District No. 13 has succeeded to all the rights of the Walla Walla Irrigation Company recognized and established by said decree and said certificate of water rights; that the Walla Walla River is an innavigable interstate stream flowing within the boundaries of the two states involved in this action, and under the facts and the laws of Congress the State of Oregon cannot in this controversy in this Court question the validity of the Gardena appropriation or its priority date, and the State of Washington objects to the introduction of any evidence to that end as not being material or relevant to the issues involved herein.

THE SPECIAL MASTER: Of course, the Court would have some trouble—I think the objection is properly in the record at this time, but I cannot pass upon the testimony until I hear what it is about—it is anticipatory—but the testimony of this witness as addressed to the subject indicated by Mr. Paul will be received subject to the objection and he need not repeat the objection as the testimony is offered.

(477) MR. RANDALL: We desire to offer in evidence the Exhibit (33).

MR. CUNNINGHAM: We object to the introduction of that exhibit in evidence for the reasons heretofore stated.

THE SPECIAL MASTER: It may be admitted subject to the objection. Counsel will not hereafter need to repeat their objections, however, to this class of testimony.

The remaining exhibits above numbered were introduced subject to the same objection by the State of Washington. (477, 479, 704, 853, 864).

OREGON EXHIBIT 42

(893) MR. CUNNINGHAM: We have no objections to the introduction of this exhibit, (except) the Gardena tabulation.

THE SPECIAL MASTER: The tabulation in Exhibit 42 referring to the Gardena project may be subject to the objection read into the record by Mr. Paul, counsel for the State of Washington.

OREGON EXHIBIT 44

(1162) MR. CUNNINGHAM: Just a moment. We would like to enter an objection to the introduction of this Oregon Exhibit 44, particularly for the reason that in the note reference is made to the right awarded by the Finis decree. As we understand the purport of that decree, it does not award any right to any water in the main streams, but merely awards, you might say, a permissive use of any water that might be tail water from the over-diversion from the Milton ditch.

THE SPECIAL MASTER: Is the decree in evidence?

MR. CUNNINGHAM: It is in evidence, yes.

THE SPECIAL MASTER: The Court will pass upon the decree.

MR. RANDALL: There is no contention, if the Court please, contrary to Mr. Cunningham's statement—

THE SPECIAL MASTER: The objection will be noted as prior to the admission of the exhibit, and the exhibit will be admitted subject to the objection.

The foregoing is respectfully submitted.

G. W. HAMILTON,
Attorney General of the State of Washington,

GEO. G. HANNAN,
Assistant Attorney General of the State of Washington,

FRED J. CUNNINGHAM,

T. A. PAUL,
Special Counsel for the State of Washington,

Attorneys for Complainant, State of Washington.

CLERK'S COPY.

Supreme Court of the United States

OCTOBER TERM, 1935

IN EQUITY.

No. 11, Original

THE STATE OF WASHINGTON, COMPLAINANT,

vs.

THE STATE OF OREGON.

ABSTRACT OF RECORD PREPARED BY THE STATE OF OREGON.

FILED OCTOBER 14, 1935.

Office Supreme Court, U.
OCT 14 1935
CHARLES ELMORE CROPLEY
CLERK

ABSTRACT OF RECORD

No. 11 ORIGINAL

IN THE

SUPREME COURT OF THE UNITED STATES

OCTOBER TERM, 1930

THE STATE OF WASHINGTON, COMPLAINANT

VS.

THE STATE OF OREGON, DEFENDANT

TESTIMONY TAKEN BEFORE

HON. WILLIAM W. RAY

Special Master

ABSTRACT OF RECORD

No. 17 ORIGINAL

IN THE

SUPREME COURT OF THE UNITED STATES

OCTOBER TERM, 1930

THE STATE OF WASHINGTON, COMPLAINANT

VS.

THE STATE OF OREGON, DEFENDANT

TESTIMONY TAKEN BEFORE

HON. WILLIAM W. RAY

Special Master

INTRODUCTION

Believing it necessary to a proper presentation of the case on the part of the State of Oregon, we have printed excerpts from Stipulations No. 3 and No. 5, and a more complete narration of the testimony of witnesses on the part of the State of Oregon. We have omitted the list of exhibits and objections, as shown at pages 251 et sequitur of the narration of testimony by the State of Washington. We have also omitted the narration of any testimony given by the witnesses for the State of Washington. We have also omitted the testimony of H. V. Whiting as unimportant.

STIPULATION No. 3

(Omitting title and Paragraph I)

II. IRRIGATION PRACTICES

The growing season in the Walla Walla Basin extends from April to October, inclusive. Irrigation during this growing season is called herein summer irrigation, and irrigation during any other part of the year is herein called winter irrigation. Winter irrigation is practiced on the lands served by the Milton, Freewater & Hudson Bay Irrigation Company, and on some of the lands of the Gardena project. The balance of the Walla Walla Basin is served by summer irrigation. In all cases where the water supply is not sufficient to supply water during the entire growing season, the practice is to store water in the soil, where possible, by irrigation prior to the growing season and whenever water is available. In summer irrigation of orchards, alfalfa and grain, outside of the gravelly soil, the practice is to apply water about once every two weeks. In areas of gravelly land, the practice is to apply water to such crops once a week. In the gravelly soil in and around Milton and Freewater, for strawberries, tomatoes, garden vegetables and short-rooted crops, the practice is to apply water two or

three times a week. Where the application is made several times a week, the period of application is from two to four hours each time. Where it is once a week, the time of application is from eight to twelve hours. Where application is made at longer intervals, the length of time depends upon the amount of acreage, and in most cases a continuous flow to each irrigator is used. The flooding method of irrigation is not practiced. Nearly all the irrigation is by what is known as the corrugation method.

It is the general practice in the orchards to grow cover crops of clover, alfalfa and the like, as a protection against evaporation. These crops are usually chopped into the soil as fertilizer.

Controlling works are found at the principal points of diversion from the stream. Weirs for measuring individual rights are in general use throughout the valley.

Rotation is practiced to a considerable extent. In Oregon, in the deep soils, the rotation period is from one to two weeks for alfalfa and grain. In the gravel soils, for orchards and alfalfa, the average irrigated acreage for a group of rotaters is about 60 acres, and rotation is practiced on a weekly basis. Where the gravel soil about Milton and Freewater is cultivated to strawberries, tomatoes, vegetables and short rooted crops, the average irrigated acreage for a group of rotaters for such crops is from 10 to 20 acres and rotation is practiced on both a twice a week and a thrice a week basis. Rotation under the Oregon decrees may be enforced by the water master, and in some instances is carried out by agreement of the parties. In Washington, rotation is practiced under all ditches operated by irrigation districts, and in the vicinity of Walla Walla, by private arrangement between the individual water users. The period of rotation varies greatly, but averages, it is estimated, about ten days.

In some instances there is a run-off from the irrigated lands, caused by the use of a large head of water. This run-off, locally called waste water, is utilized on succeeding tracts.

In the section around Milton and Freewater, there are approximately 300 wells which pump water from the lower gravel strata and apply it to irrigation. In Washington there is little irrigation from wells.

III. CROP PRODUCTION

Oregon. In Oregon the crops consist of wheat, alfalfa, hay, prunes, apples, cherries, tomatoes, berries, vegetables and nursery stock. In the irrigated section there are from 3000 to 4000 acres of prunes, yielding about 6 tons to the acre; from 1000 to 1800 acres of apples, yielding about 8 tons to the acre; 200 to 300 acres of cherries, yielding about 4 tons to the acre; about 200 acres of tomatoes, yielding 10 tons to the acre. (The acreage of tomatoes has been cut down this year from past years, in accordance with the general policy of cutting the amount of production. Last year the acreage was about 300 acres.) There are about 125 acres of berries, yielding about a ton to the acre. Nursery stock of about 175 acres supplies about 40 carloads per year, besides the local market. Alfalfa hay is raised on from 2000 to 2500 acres of land, and yields from 5 to 7 tons per acre, depending on the length of time that water is available for irrigation. In this district there are approximately 2500 dairy cattle, exclusive of those kept for family purposes only. In the line of vegetables, squash, melons, potatoes and other varieties yield in proportion to the tomatoes. There has also developed a considerable flower trade. A number of growers specialize in peonies, supplying the trade not only with peony blooms but with the plants.

Washington. The crops of the valley in Washington consist principally of alfalfa, wheat, vegetables and fruits. It is estimated that 40,000 tons of alfalfa are raised in this area annually. The average acreage yield is 6 tons. Wheat on irrigated land is generally raised as part of the rotation between alfalfa plantings. It is estimated that 1000 acres of wheat are irrigated in this area annually. The average

acreage yield is 50 bushels. Crops of vegetables are grown quite extensively. The average annual yield of the following varieties is: Head lettuce, 49 cars; cabbage, 16 cars; rhubarb, 35 cars; onions, 300 cars; spinach, 100 cars; tomatoes, 30 cars, cantaloupes, 46 cars; potatoes, 307 cars; mixed vegetables, 84 cars. The average acre yield of the following varieties is: Asparagus, 500 boxes to the acre; spinach, 500 boxes per acre; onions, 600 sacks per acre; potatoes, 200 sacks per acre. Fruits are also grown in this area. In 1932, 125 cars of apples and 302 cars of prunes were estimated to have been shipped out of Walla Walla. Apples in this territory yield from 5 to 10 boxes per tree. Prunes yield as high as 600 boxes to the acre. The sweet varieties of cherries are grown, yielding as high as 100 pounds to the tree. It is estimated that 145 tons of cherries were raised in 1929. Peaches and pears are grown successfully principally for the local market. 16 tons of peaches were raised in 1929. An average of 10 cars of grapes are shipped from Walla Walla annually. Strawberries yield as high as 600 crates to the acre. Approximately 100 acres in this area are devoted to berry culture. It is estimated that there are 4000 milk cows on the farms in this area. Two and three-quarter million gallons of milk were produced in 1929. Poultry is also raised extensively. 7500 turkeys, 1600 ducks and 1000 geese were estimated to have been raised in this area in 1929. $47,000.00 was also realized from the sale of chickens in that year.

IV. DEVELOPMENT OF COMMUNITY

Oregon. The Oregon community supports a flour mill, a sawmill and box factory, cider works, a dehydrating plant and a vinegar plant, in addition to a number of commission houses and fruit and vegetable distributors. In order to handle the fruit and vegetable crops, five cold storage houses have been erected and are operated by the various companies.

The district contains ten grade schools, having a total of about 1000 pupils, and a splendid Union High School. There are about ten churches. This property, together with the municipal buildings of the two towns, represents a value of about half a million dollars.

Washington. In the city of Walla Walla there are 66 manufacturing plants, including four flour and feed mills, a meat packing house, a cannery, specializing in vegetable canning, three creameries, an iron products foundry, two sash and door factories, a concrete pipe and conduit plant, and other small manufacturing enterprises. The annual value of the products of these industries is $6,279,166.00.

The city of Walla Walla supports a high school, six grade schools, three parochial schools, three music schools and two colleges, with an aggregate average annual attendance of 5300 students. There are twenty-four churches, representing all principal denominations, four theatres and three hospitals. Grade schools and churches exist and are well distributed outside the city in this area.

V. POPULATION, FARM ACREAGE AND ASSESSED VALUATION

The territory herein considered excludes all that part of the river basin which by stipulation has been heretofore removed from any issue in the case.

Oregon. The related territory in Oregon, excluding the Hudson Bay lands, has a population, according to the 1930 census, of 4772, of which 2308 is urban, being the cities of Milton and Freewater, and 2464 is rural. In addition, the Hudson Bay lands are occupied by about 65 families, which would raise the total population of the district to about 5000.

The irrigated lands are farmed intensively. The 6233.87 acres irrigated from the Walla Walla River, spring branches and East Prong of the Walla Walla, are divided into 889 farms, with an average acreage of 7.01 acres. The West

Prong and Lewis Spring Branch have 618.74 acres, divided into 36 farms with an average acreage of 17.19. The Pleasantview Ditch Company irrigates 1249.18 acres, divided into 62 farms with an average acreage of 20.15. The Milton, Freewater & Hudson Bay Irrigation Company irrigates 2675.41 acres, divided into 57 farms, with an average acreage of 47 acres. This makes a total acreage in the related area of 10,777.20, divided into 1044 farms, or an average acreage of 10.32 acres.

This acreage has an assessed valuation, on the 1932 roll, exclusive of the Hudson Bay acreage, of $1,543,120.00. The Beauchamp land, of 86.67 acres, irrigated under the Hudson Bay, is assessed at $11,810.00, and the Markham land, 200 acres, is assessed at $21,560.00. Based upon these assessments, it is estimated that the assesed value of the Hudon Bay lands is substantially $250,000.00. The assessed valuation of the cities of Milton and Freewater is $915,975.00. This makes a total assessed valuation of the related district of $2,709,095.00. The assessed valuation is usually counted as averaging about fifty per cent of the actual value.

Washington. The related territory in Washington, outside the incorporated towns, has a population of 7090, according to the 1930 U. S. census. The population of the city of Walla Walla, according to the same authority, is 15,976. There are 9615 acres of irrigated land in the vicinity of Walla Walla. The size of the farming units in this area varies from 1 to 500 acres. The average is 17 acres. In the vicinity of Lowden there are 3231 acres, ranging in size of unit from 2 to 160 acres, with an average of 38 acres. In the Gardena district, the smallest unit is 4 acres, the largest 200 acres, and the average 70 acres.

The above described acreage in the vicinity of Walla Walla has an aggregate assessed valuation, on the 1932 tax roll, of general taxes, of $3,845,942.00. The assessed valuation of lands in the city of Walla Walla for the same year is $8,137,409.00. In the vicinity of Lowden, lands were as-

sessed for the same year at $225,670.00, and in the Gardena District, at $234,663.00. The total aggregate assessed valuation of the land in the related area is $12,443,684.00. Under the law in the State of Washington, lands are assessed for taxation purposes at fifty per cent of their actual value.

PRIORITIES AND APPROXIMATE ACREAGES, AS SHOWN BY DECREES AND PERMITS

The following tabulation shows the approximate acreage under each year's date of priority, as shown by the several decrees of the two states, for the related area, excluding all that part of the river basin which by stipulation has been heretofore removed from any issue in the case, and including the Gardena appropriation, the priority of which is contested by Oregon and reserved for further hearing:

	OREGON			WASHINGTON		
Year	Walla Walla River	Waste	West Pg. in Oregon	Walla Walla River	Tributaries	West Pg. (Little W. W. R.)
1859	.....	.....	.....	.....	37.15	.....
1861	.....	.....	.....	.....	314.00	.....
1862	35.84	.....	.....	.....	.....	.....
1863	.....	.....	.....	.....	83.50	.....
1864	38.22	.....	.....	.....	81.61	.....
1865	37.12	.....	.....	.....	124.23	.....
1866	3.30	.....	.....	.....	137.13	.....
1867	8.24	.....	.....	.....	.....	.....
1868	60.28	.....	.....	.....	89.90	.....
1869	4.18	.....	.....	.....	44.45	.....
1870	47.31	.....	.....	160.00	85.83	.....
1871	11.06	.....	.....	.....	.....	35.00
1872	55.78	.....	.....	.....	79.75	.....
1873	65.50	.....	.....	.....	13.00	.....
1874	25.26	.....	.....	.....	.....	.....
1875	291.47	.....	.....	.....	20.40	.....
1876	72.90	15.00	.....	.....	1.32	.....
1877	87.73	.....	.....	.....	12.00	.....
1878	81.74	.....	.....	.....	54.77	.....
1879	31.55	.....	.....	.....	.....	.....
1880	180.17	.....	43.80	.....	25.20	.....
1881	123.46	.....	7.50	.....	51.50	.....
1882	86.90	.....	.....	.....	91.00	.....
1883	55.09	.....	13.00	.....	61.73	.....
1884	16.50	.....	.....	125.00	149.48	.....
1885	135.35	.....	14.00	.....	94.58	.....
1886	54.51	.....	32.00	.....	141.35	20.00
1887	217.76	.....	.....	.....	30.50	.....
1888	93.38	.....	.....	.....	.....	.....
1889	65.86	.....	.....	.....	98.91	462.90

Year	OREGON			WASHINGTON		
	Walla Walla River	Waste	West Pg. in Oregon	Walla Walla River	Tributaries	West Pg. (Little W. W. R.)
1890	113.72	10.00	60.29	.....	48.50	.....
1891	131.49	.....	.....	.....	178.67	29.00
1892	264.05	10.00	15.00	8,221.11	647.63	.....
1893	157.54	.....	9.75	431.96	18.00	.....
1894	102.12	.....	82.00	.....	477.97	187.70
1895	242.07	.....	75.50	.....	246.75	.....
1896	30.72	.....	.....	180.79	.....	65.00
1897	128.31	.....	10.50	.....	141.25	.....
1898	44.37	.....	9.50	.....	160.00	.....
1899	7.06	.....	.....	.....	6.50	.....
1900	198.99	.....	50.00	.....	99.33	.....
1901	87.69	49.90	11.00	.....	105.45	1.00
1902	165.90	33.90	72.00	.....	38.00	52.00
1903	2,725.04	15.30	7.50	40.00	147.06	.....
1904	23.02	8.70	14.50	330.00	884.58	.....
1905	136.35	12.80	.....	.....	25.05	10.00
1906	40.06	.....	16.00	.....	123.75	.....
1907	80.99	8.75	7.00	50.00	153.15	.....
1908	193.82	38.84	16.70	.....	202.55	106.00
1909	316.71	.....	.....	.....	42.00	.....
1910	33.25	.....	.....	.....	32.28	.....
1911	.....	.....	.....	.....	50.00	.....
1912	962.14	.....	.....	15.00	371.00	.....
1913	392.25	.....	.....	.....	83.19	.....
1914	14.00	.....	.....	.....	136.50	.....
1915	97.00	.....	.....	.....	63.10	.....
1916	28.80	.....	.....	.....	.40	33.00
1917	59.00	.....	.....	.....	63.28	21.00
1918	28.00	8.00	.....	.....	49.90	.....
1919	59.00	.....	9.25	5.00	29.00	35.00
1920	27.50	15.00	32.00	50.00	61.74	32.00
1921	12.00	.....	.....	.....	75.52	.....
1922	140.00	113.00	.....	.....	3.60	.....
1923	140.00	37.00	.....	.....	11.00	.....
1924	91.00	5.00	.....	35.00	6.00	.....
1925	41.00	25.00	.....	.....	.50	.....
1926	3.50	.....	10.00	880.00	1,419.80	49.00
1927	90.40	.....	.....	15.00	.....	.....
1928	281.15	.....	.....	.....	25.00	.....
1929	30.00	.....	.....	.....	7.50	.....
1930	44.30	.....	.....	.....	.....	.....
1931	1.00	.....	.....	.....	.....	.....

STIPULATION NO. 5

The following are excerpts from the above stipulation, relating to Gardena: (Exhibits A, B, C, D, and E attached to the stipulation are not printed).

The following facts are hereby stipulated and agreed.

The largest diversion from the Walla Walla River in the State of Washington is for lands served by the Gardena

Farms District Canal, formerly Walla Walla Irrigation Company Canal. At a point approximately twelve and a half miles West of the diversion point and in the SW¼ of the NW¼ of Section 5, Twp. 6 North Range 34 E. W. M., the canal enters a syphon, through which it crosses Pine Creek Valley and emerges therefrom in the NE¼ of the SE¼ of Section 12, Twp. 6 Range 33 E. W. M.

By decree in the Superior Court of the State of Washington for the County of Walla Walla, in the case of State of Washington, plaintiff, vs. Charles Achermann et als, defendants, No. 19075, the Walla Walla Irrigation Company, under Proof No. 570, was given a right from the Walla Walla River, by appropriation under a priority date of 1892, to irrigate 7000 acres of land with a maximum amount of water of 93.333 c. f. s. from April 1st to July 1st, and 70 c. f. s. of water from July 1st to October 1st, subject to the following Note:

> That claimant's 5,000 acres of land, which was the amount irrigated at the time of the hearing of the claim of said Walla Walla Irrigation Company before the referee, to-wit, on the 29th day of March, 1926, is entitled to use of water to the extent of 66.67 cu. ft. per second from April 1st to July 1st; 50 cu. ft. per second from July 1st to October 1st, and 1 cu. ft. per second for each 50 acres of land for winter irrigation; provided, that from and after said 29th day of March, 1926, the remaining lands susceptible to irrigation which may in the future be developed, shall be entitled to a quantity of water for irrigation at the rate herein allotted, as said land may be brought into cultivation from time to time until a maximum of 7,000 acres are developed and the maximum of water herein awarded is used; and that the amount of land to which this claimant is entitled to water under the above provision shall be determined at the beginning of the spring irrigation season each year, by the State Supervisor of Hydraulics.

In the year 1928, an irrigation district was formed, known as the Gardena Farms District, which acquired the rights of the Walla Walla Irrigation Company.

In the beginning, J. F. Boyer, T. J. Kirk and W. F. Courtnay caused preliminary surveys to be made and a canal route to be located. Several notices of appropriation were posted at the proposed point of diversion and recorded in the office of the proper recording officer of Walla Walla County, State of Washington, copies of which, with date of record, are hereto attached, made a part hereof and marked Exhibit "B", "C" and "D" for diversion from the Walla Walla River and Exhibit "E" for diversion from the Little Walla Walla River. No diversion was ever made from the Little Walla Walla River.

In the spring of 1892, E. C. Burlingame, a contractor, became interested in the project and made further surveys and investigations of the route of the canal, and thereafter acquired an interest therein.

Soon thereafter in the same year a corporation was formed, known as the Walla Walla Irrigation Company. On November 5, 1892, formal conveyances of the rights of the individual appropriators were made to the Company, by deed recorded January 24, 1893, in Book 53, at page 179, Deed Records of Walla Walla County, Washington.

Mr. Burlingame performed the construction work for the Company using his own equipment and teams up to the time of the formation of the irrigation district which succeeded to the rights of the Company in 1928.

In August 1892 actual construction work on the canal was begun.

Prior to the year 1905 the canal was constructed from the diversion point in the McBean donation land claim in the SW¼ SW¼, Section 3, Twp. 6 North Range 35 E. W. M. along the route of the canal as shown on the official map herein, to a point in Lot 3 of Fractional Section 13, Twp. 6 North Range 34 E. W. M. where the map indicates that the canal divides. From said divisional point one division of the canal was constructed in a Southwesterly direction into the State of Oregon, and also from said divisional

point, prior to the year 1905, one division was constructed in a Northwesterly direction along the route indicated on the map to a point in Section 5, Twp. 6 North Range 34 E. W. M. about a mile from the upper end of the syphon.

In the winter and spring of the year 1905 an inverted syphon was constructed from a point in the SW¼ of the NW¼ of said Section 5, to a point in the NE¼ SE¼ of Section 12, Twp. 6 North Range 33 E. W. M. from which point the distribution system for the irrigation of the lands West and South of the syphon was constructed and has been extended as the demands of irrigation required. This syphon has a head of 145 feet, carries the water of the canal across the valley of Pine Creek a mile and a half in width, and is built of wood staves and steel bands. It was orginally of a diameter of 38 inches and has since been replaced by Gardena Farms District by one 44 inches in diameter.

For the first three miles of the course of the canal from the river the soil conditions presented no serious difficulties in construction. From there to the head of the syphon the course of the canal was in light and ashy soil requiring the canal to be puddled and causing some breaks and slides. The excavation and filling was done with teams and scrapers.

As a part of this construction work there were cuts two of which were approximately 26 feet in depth at their deepest point, one about 1500 feet and the other about 1000 feet, in length. Some fills also had to be made. The canal was constructed 16 feet on the bottom from the diversion point to the division of the canal at the point in Lot 3 of Fractional Section 13, Twp. 6 North Range 34 E. W. M. and from that point to the head of the syphon is now 10 feet on the bottom, all with side slopes of 1½ to 1 and with a depth of about 6 feet. The canal has a fall of .5 of a foot to a 1000 feet and a capacity of 150 c. f. s. in that portion with 16 feet bottom.

• • • • •

Such records of the Company as are now available do not segregate the cost of construction of the canal which began in the year 1900 and which was constructed from the divisional point in Lot 3 of Fractional Section 13, Twp. 6 North Range 34 E. W. M. into Oregon.

In the year 1910 the Company entered into arrangements to receive sewage water from the City of Walla Walla and during the years 1910, 1911 and 1912 expended $49,253.92 for concrete sewer pipe, $3954.02 for construction work, $1471.64 for engineering, and $1771.60 for rights of way, for the purpose of conveying such sewage water to the Company's canals. This water was used until the year 1924 when such use was discontinued and the works abandoned, with the exception of a small part of the concrete pipe used for a spillway from the canal. From about 1920 to 1924 the Company contracts for the sale of water contained the following clause: "It is understood that sewage water from the City of Walla Walla is part of said water supply."

In the year 1907 the Company expended $798.00 in investigation of reservoir sites. No reservoir has been secured. The Company also expended for the drilling of wells, the following sums: In 1905, $240.50; in 1909, $6155.50; and from 1910 to 1913 the sum of $441.25, and in 1924 and 1925 the sum of $3149.08, making a total of $9980.33 expended for work in an attempt to develop an additional water supply from wells, which was without result.

Water was first diverted from the river into the canal in the year 1893 for puddling purposes and turned out through the spillway into the West Little Walla Walla River. In the year 1898 water was first used for irrigation when 63 acres along the line of the canal were irrigated. In 1899, 20 additional acres were irrigated but these latter mentioned lands have since been abandoned. In 1901, 280 acres were irrigated in Oregon from the canal running from the divisional point in Lot 3 of Fractional Section 13, Twp. 6 North Range 34 E. W. M. into Oregon, and between 1901

and 1918, 72 additional acres in Oregon were irrigated from the canal, but the irrigation of these lands was discontinued in 1919, when the Company abandoned the operation of this canal. These lands are now irrigated from the Milton-Freewater and Hudson Bay Ditch. In 1898, 68 acres were watered from the canal; in 1899 two acres additional were watered in Washington, which were later abandoned.

In 1904, 193 acres were watered from the canal in Washington, including the 20 acres above mentioned as later abandoned. Approximately 1133.4 acres East of the syphon in Washington are now irrigated from the canal. The balance of the lands irrigated from the canal lie west and south of the syphon. Water was first run through the syphon in 1905 and used for irrigation.

(Tabulation of contracts for water omitted.)

The foregoing tabulation of water contracts sold by the Company up to 1930 totals 5793.09 acres. Of this amount 372 acres were later abandoned, leaving water rights outstanding for 5421.09 acres, of which there are 201.11 acres in Washington and 15.45 acres in Oregon for which irrigation payments are being made, but which are not now being irrigated. A survey by Oregon indicates that in 1933 there was irrigated from the system 4530.2 acres in Washington and 721.3 acres in Oregon, being 46.97 acres more than the above tabulation.

EXHIBIT "F"

WALLA WALLA IRRIGATION COMPANY—DEVELOPMENT BY YEARS

Years	Construction	Wood Pipe	Concrete Sewer Pipe	Concrete Pipe	Reservoir	Engineering	Rights of way	Wells	Totals
1892-1893	7,727.09					1,536.80	2,836.50		11,600.39
1894-1895-1896	11,812.90					50.00	301.50		12,164.40
Totals						1,586.80	2,638.00		23,764.79
1897 to 1904 Inc.	27,536.87					218.45	2,214.67		29,969.99
Totals	47,076.86					1,805.25	4,852.67		53,734.78
1905	27,307.47	15,218.29				1,361.10	85.00	240.50	44,212.36
Totals	74,384.33	15,218.29				3,166.35	4,937.67	240.50	97,947.14
1906	12,575.75					913.90	339.00		13,828.65
Totals	86,960.08	15,218.29				4,080.25	5,276.67	240.50	111,775.79
1907	7,405.32				798.00				8,203.32
Totals	94,365.40	15,218.29			798.00	4,080.25	5,276.67	240.50	119,979.11
1908	15,617.92					17.60			15,635.52
Totals	109,983.32	15,218.29			798.00	4,097.85	5,276.67	240.50	135,614.63
1909	16,653.39					857.70	800.00	6,155.50	24,466.59
Totals	126,636.71	15,218.29			798.00	4,955.55	6,076.67	6,396.00	160,081.22
1910	3,954.02		34,389.70			1,471.64	1,771.60	122.50	41,709.46
Totals	130,590.73	15,218.29	34,389.70		798.00	6,427.19	7,848.27	6,518.50	201,790.68
1911			14,713.67					178.75	14,892.42
Totals	130,590.73	15,218.29	49,103.37		798.00	6,427.19	7,848.27	6,697.25	216,683.10

1912			152.55						152.55
Totals	130,590.73	15,218.29	49,255.92		798.00	6,427.19	7,848.27	6,697.25	216,835.65
1913								140.00	140.00
Totals	130,590.73	15,218.29	49,255.92		798.00	6,427.19	7,848.27	6,837.25	216,975.65
1914-1915	252.95								252.95
Totals	130,843.68	15,218.29	49,255.92		798.00	6,427.19	7,848.27	6,837.25	217,228.60
1917 Dam at river	1,300.38								1,300.38
Totals	132,144.06	15,218.29	49,255.92		798.00	6,427.19	7,848.27	6,837.25	218,528.98
(Gardena) 1920 concrete pipe				5,400.50					5,400.50
Totals	132,144.06	15,218.29	49,255.92	5,400.50	798.00	6,427.19	7,848.27	6,837.25	223,929.48
1924								1,500.00	1,500.00
Totals	132,144.06	15,218.29	49,255.92	5,400.50	798.00	6,427.19	7,848.27	8,337.25	225,429.48
1925								1,649.08	1,649.08
Grand totals	132,144.06	15,218.29	49,255.92	5,400.50	798.00	6,427.19	7,848.27	9,986.33	227,078.56 Cost of system

The item "Wood Pipe" $15,218.29 is the wood stave pipe across Pine Creek to Gardena. Estimated cost about $25,000.00. The item "Concrete Pipe" 1920—Gardena is the pipe extending West along South line Section 5-6-33 to Paine land.

A narration of the testimony of the witnesses on the part of the State of Oregon is as follows:

E. C. Burlingame

I am 75 years of age; reside in Walla Walla. Became connected with Walla Walla Irrigation Company in 1892. (R. 458.)

At request of Mr. Courtney and Mr. Boyer. (R. 460.)

I took an engineer and started over the survey, found a short cut, reported to Mr. Boyer, became one of the company, took charge of construction work and started construction with a man and team, plowing furrows and scraping out ditch. Remained until ditch was completed. (R. 461, 462, 463.)

In 1892, worked first a few days to comply with the law, then later in same year put in grading outfit and camps and went to work and continued until depression of 1893 attacked me. (R. 464.)

We shut down in the fall of 1893. Left one man and four teams and the camp equipment on the work. I kept that one man here for about 2 years. My headquarters were in Yakima. In '95 we came back and started construction work. (R. 465.)

I had 3 or 4 men besides myself until the spring of '96. In spring of '96 I went to Montana with the outfit and left a man puddling the ditch. I finished the big cut in '95. (R. 466.)

From '92 to '96, canal had progressed about 2½ miles out of a total length proposed of 25 to 27 miles. I came back in fall and winter of '97, put a crew to work of 3 or 4 men with four horse teams and a plow team. The Locker place was first land irrigated in '98 or '99. (R. 467.)

There were 68 acres in that farm. Irrigation was started that year. (R. 468.)

In 1892-3 spent $11,600.39 for engineering, construction and rights of way, $7727.09 of that for construction. In 1894-6, $12,164.40 for construction. Left an outfit there 2

years. In fall of '95 or spring of '96, I came over with my foreman and small outfit of teams and went to work at Locker place. It was 1899 when I started to irrigate Locker place. In 1898 I worked for U. P. at Potlatch near Lewiston, also on a placer mine near Grangeville, also water works for that town and also on O. R. & N. Snake River cutoff. (R. 469, 470.)

There was no construction during time I was working elsewhere, except one man kept there. I went to Montana and came back from Palouse ditch and put in the winter of '97 and spring of '98 on the canal on the Locker place. Then went to Wallace, Idaho. In the summer of '99 and spring of 1900 I worked on Locker place. (R. 471.)

Then worked on railroad at Hamilton, Washington. There was no construction going on during the time I was gone. I was irrigating the Locker place. '96 was first year I took out water and carried it past little Walla Walla. Used the water for puddling the ditch. In 1900 was first year I irrigated Locker place. I built a house and put a man to work there and did a good deal of work on the ranch in 1900 as well as the canal. In 1901, I did no construction work. (R. 472.)

In 1902, I was building Kennewick canal for the N. P.-R. R., and in August of that year, I sent men and teams and commenced work again on the canal. About 3 fresnos and a foreman. Finished Kennewick job in February 1903 and then moved to Walla Walla Irrigation Company ditch and went to work. Took charge myself from then on. (R. 473.)

I had a map of the project made by E. H. Guilland. Ex 0 23 is tracing of original survey. (R. 474.)

Referring to Walla Walla Irr. Co. on map and line of dots beyond, map shows that somebody has added a new line of marks not made by the original engineer. I do not know who made them. They were not originally on the map. This map was in my office. (R. 475.)

The map as originally drawn and before the alterations was a correct representation of my then plan for the Walla

Walla Irrigation Co. canal. The original plan was according to dotted line running down across the State line into Oregon. (R. 476.)

It is a part of the Company records. Ex 034 is a part of the original survey. (R. 477.)

Some red crosses on it have been added; probably indicate new land to be taken in, some contemplated change. Referring to line on blue print beginning in NW¼ Sec. 13-6-34 and extending to center of Sec. 5-6-34 and marked "lateral", this is now the main canal. Referring to line beginning at division point in Sec. 13 and running southerly and westerly across state line into Oregon, marked "main canal", that indicates the route of the proposed main canal up until 1903. This blue print is part of the records and files of Walla Walla Irrigation Co. (R. 478, 479.)

Ex. 0 35 is part of records and files of Walla Walla Irrigation Co. Referring to words in white ink "W. W. I. Co. main canal" and line drawn through word "lateral" and line in white ink from line in Secs. 5 and 6 to present syphon, those were put in after blue print was made. I do not know by whom or when. Referring to word "south" in white ink and a line drawn through "main", I do not know when or by whom made. Without those changes, blue print delineates original plan of W. W. Irr. Co. canal. (R. 480, 481.)

Present construction is about as outlined by the changes. I made the change to the present construction in 1903. Made change because I discovered that we were leaving out the best land in Gardena that could not be irrigated as originally planned. (R. 482.)

The high lands in the east end of Gardena, consisting of 2½ to 3 sections, could not be irrigated under original plans. We started to build Gardena lateral in 1904. In winter of 1903-04 we decided to build syphon, that it would save water, get more land, and the land would pay the cost of the pipe line. (R. 483.)

At that time we had constructed into Oregon 15 to 18 miles to about center of Sec. 19-6-34 in Oregon. I had run water across Pine Creek to a mile east of that point and irrigated the Neitert place. The canal in Oregon, originally the main canal, has since been abandoned, about 1918 or '19. After that, Hudson Bay took over the best of it, beginning about ½ or ¾ mile east of Pine Creek. Original canal was surveyed and stakes set through Gardena. Syphon was constructed in 1905, and land first irrigated on the hilltop in Gardena. Up to 1919 I irrigated my Oregon ranch from what was originally intended to be the main canal. It is now irrigated from Hudson Bay. Owing to financial trouble I had to go slow in construction. There was nothing else. When I first went up the Walla Walla Irrigation Co. in 1892, I made no investigation of water supply. Took it for granted that these men, old timers that lived here, knew all about the river. (R. 484, 485, 486, 487.)

After I completed canal and commenced using more water, I discovered the river didn't have as much water as we thought and began to investigate. I went up the river several times, above the McCoy Bridge, clear up to the East side ditch, looking for hostile diversions, if somebody was taking the water that belonged to us. I found no one. The river, Tumalum, between Nursery Bridge and McCoy bridge, was bare rocks, dry. (R. 488.)

I went up there in August and September. We were getting shy in August. Generally didn't have much trouble in July. I went up once in July, looking for somebody starting new ditches, but didn't find any. I wasn't interested in Hudson Bay ditch then. I became interested in the Hudson Bay ditch in 1911. (R. 489.)

I then began to look after the operations of that company and its water supply. I employed Mr. Bowman as ditch walker on the Hudson Bay ditch. As part of the Hudson Bay system, a canal leads from Tumalum to Little Walla Walla, emptying below Peacock Mill and above the frog, and has a headgate and diversion dam. The first thing

I did after getting control, I put men in there and tore out all the trees and cleaned out the ditch. (R. 490.)

I diverted water from Tumalum to Little Walla Walla through that ditch. During shortage I let water down once in June, 1928, a thousand inches. Did not see how far it went, but ditch walker, Orin Bowman, did. (R. 491.)

At time turned water, I don't think Tumalum was quite dry. Always a small stream at Highway bridge. (R. 492.)

I have been up above McCoy bridge many times hunting for water. Always dry between McCoy and Nursery bridges in August or September. Might have been tiny seepage scattered through rocks. I know Carl Hartvedt. I hired him in 1917 to work for Walla Walla Irrigation Co. (R. 493.)

I do not remember ever going with him to where Hudson Bay takes out of the Tumalum and closing the Hudson Bay to turn water down to Gardena. I couldn't instruct Hartvedt to go up there and turn it down. The gate at the end of the ditch is kept locked and Bowman carries the key. I never instructed him to turn it down. As a result of the shortage of water, I made an investigation as to possible reservoir sites. (R. 494, 495.)

Spent $796.00 in surveys in Blue Mountains and all over the country looking for storage sites. Found nothing worthy of consideration. We dug two wells to develop Artesian water. One at College place, the other near headgate of ditch, spent $9986.33 in 1924 or '25, but did not secure any water. (R. 496.)

Also as a result of shortage of water, I arranged to get sewage water from City of Walla Walla, spent about $50,000 for pipe line and right of way. Expenditures show in Ex. F of Stip. No. 5 in 1910 of $34,389.70 for sewer pipe, $1471.64 for engineering, $1771.60 for rights of way and a total of $49,255.92 for concrete sewer pipe, for that purpose. This includes construction charges. I built the pipe myself. These expenditures were in 1910, 1911 and 1912. We expected to get 10 c. f. s. of water and built a pipe for that, but only got a maximum of 6½ c. f. s. We got in litigation

over it and abandoned it, 5 or 6 years ago. All this expenditure for sewer line, wells and reservoir sites produced no water that is now being used. The development in Gardena was largely completed at the time I left, before Gardena Farms District was organized. I left about 1930. In that development, took no water down the Tumalum in short season during July, August and late June, only what rises at and below McCoy Bridge and spring branches, Big Spring, East Prong and numerous branches above the headgate. Rights up Yellowhawk and Mill Creek were shut off to supply Gardena before I left the company. (R. 497, 498, 499, 500, 501.)

(Cross examination)

Canal flows west through E½ Sec. 11. Sec. 12 is highest irrigated land in Gardena irrigated by gravity flow.

Elizabeth S. Burlingame, my wife, made desert entry on part of W½ Sec. 11-6-33 on Feb. 11, 1901. I also made a desert land entry on part of W½ Sec. 11 in 1893. (R. 502.)

I turned water in canal when I reached Little Walla Walla, 1⅝ miles, and let it run into Little Walla Walla. Put in large tracts of orchard in Gardena in '05 and '06 and sold some of them with contract to care for them, for five years. In 1917, employed Hartvedt. He stayed until 1922. Came back in 1926 and has remained to the present. He is a competent man. I was witness in Walla Walla adjudication in Washington. (R. 503, 504.)

In 1917, when Mr. Hartvedt went into my employ. Mr. Paine and I owned all the stock in Walla Walla Irrigation Company. A few years later I bought out Mr. Paine. (R. 506.)

At same time we owned one share over 50% of Hudson Bay stock. I bought Paine stock and since then control the Hudson Bay Co. (R. 506.)

Walla Walla Irrigation Co. has large holdings in Gardena, 500 or 600 acres, irrigated from canals. (R. 507.)

I am farming a large area irrigated from Hudson Bay ditch. (R. 508.)

Orin Bowman

Orin Bowman lives at Milton, Oregon, employed on Milton, Freewater & Hudson Bay Company canal since 1919. (R. 510.)

I have charge of distributing water and caring for ditch. Have charge of headgates. Have had charge of headgate where Hudson Bay canal takes out of Tumalum since 1920. It is locked with a padlock and I carry one of the keys. (R. 511.)

Gate is closed when there is a surplus of water. We turned water down the Tumalum once to get water to Gardena. That was in 1928 for a couple of days along about the 1st of June. We turned down about 1000 inches or 25 c. f. s. It went pretty near to McCoy Bridge in two days. (R. 512.)

After seeing it disappear there, I went back and turned it down to the users who had it in the first place instead of running it into the ground to waste. I turned it to Hudson Bay canal and continued to use it. It lasted about a week. That is the only time it was turned down. (R. 513.)

I was present once when Hartvedt and Burlingame came over and wanted water turned down. Mason, the deputy water master, would not turn it down. During period of shortage, as fast as water drops in river, we keep taking up water until it is all gone. (R. 514.)

During the time I was on the ditch, never another time was water turned down to Gardena. I live at the headgate on Little Walla Walla, at the frog. Every morning and evening, during irrigation time, I went to Tumalum headgate. At low water time I would seal up the Tumalum dam tight and divert all the water from Tumalum to Little Walla Walla. (R. 515, 516.)

(Cross examination)

Went to work for Hudson Bay Co. in fall of 1919. A new headgate was put in, in 1920, in the fall, at the Tumalum, under supervision of Carl Hartvedt. (R. 516.)

It is concrete form with wooden gate. He also constructed measuring weir just before canal enters Little Walla Walla. Not used now. (R. 517.)

A dam of rocks turned water in. Don't know whether Hartvedt had a key to the headgate. (R. 518.)

They never bothered it. Water could be turned down Tumalum either by removing dam or closing headgate. When I turned water down in 1928 I went down in sight of McCoy Bridge. I went to headgate every morning to regulate it in cooperation with water master. (R. 519.)

(Redirect examination)

Water master did not require me to cease taking water from Tumalum. I adjust the headgate to keep from taking too much water, keep the right amount regular, not adjusted while short of water. Hartvedt never came to me to turn water down and I never found gate changed. Several times found flash boards removed. (R. 521.)

Either someone kicked them out or a log came down river and knocked them out. I put them back as quick as I could get them in. They never remained out as long as two days. Water master requires me to regulate gate at Tumalum all the time, that is, when there is plenty of water. The river raised last night and I had to go over there and pull out some of those boards to guard against flooding. Water master does not require me to adjust to cut down water where Hudson Bay is short. One gate is at the Tumalum, one at the frog. We regulate both, but amount of water that goes into ditch for distribution is regulated at the frog. (R. 522, 523.)

William Forsythe

William Forsythe lives northwest of Freewater about 2 miles. Have lived there 48 years and been in and around Milton since 1879. Farm is 1¼ miles west of Tumalum, 21½ acres growing fruit, apples, strawberries, tomatoes, cherries. I worked in meat business in 1882. Saw Tumalum

in 1880. In 1882, I run a butcher shop in Milton and crossed Tumalum during harvest season twice a week over and back, peddling meat. Crossed about a mile or 1¼ mile below railroad bridge, beside the Nursery bridge. Stream bed in 1882 was dry in July and August. (R. 525, 526, 527.)

Road was fixed with straw and manure to break the jolts, because rock was so big. After 1882, worked in shingle mill, then went to Salem two years, and came back to present farm in 1886. I have seen stream most every year. I never found any water in it after the middle of July. Usually went dry about first of July, some years earlier. (R. 528.)

I have four wells. Water in them rises in February or March and they are dry in January. In summer I have water very near to the top of the well; rises there in May or June. Wells are about 36 feet deep. Loose gravel for about 12 feet from the top then cement gravel. Gravel would have soil mixed with it for about a foot or two. (R. 529, 530.)

In early years helped turn water from Tumalum into Little Walla Walla. The first year was 1886. Had to dig a new channel altogether. The flood water had washed the Walla Walla river full of gravel and we had that all to dig out. (R. 531.)

The work was done at the division point of the two rivers and turned the stream into Little Walla Walla for the purpose of irrigating. In 1882, or 1883, the river changed its channel for one-fourth mile just above the division. River down the Tumalum changes its channel more than up river. (R. 532.)

Prior to 1886, they had to do work on the channel to turn water into Little Walla Walla. (R. 533.)

After 1886, we didn't have to dig a new channel every year, but we had to put in dams to get the water into the Little Walla Walla. Always left some water in Walla Walla; I don't know how much. Had to fix dams several

times through the summer, most every year, because the water was lower in the river. (R. 534.)

Before the decree, there was a good deal of water trouble. (R. 535.)

(Cross examination)

I settled in Milton in 1879. No change of channel between 1879 and 1882. I couldn't find plenty of water in the early days. (R. 536.)

In July and August in early days I worked in the mill, had two mill races. Miller's mill and the shingle mill, and we had to take about all the water there was to get the two ditches filled full. Shingle mill was just below Miller mill. It's all gone now. After fall rain started each year, water would flow in Tumalum. (R. 536, 537.)

Dug first well about 1896 or 1897. I dug one in 1906 or 1907 and another on 20 acres. In first well observed rise and fall of water. (R. 538.)

At time it was first dug, it raised just the same as at present. I get my irrigation from the Ford branch. That's the reason we worked at Tumalum division, to get more water down Little Walla Walla. All the neighbors would go up there, take turn about going up there and turning water. Now the irrigation district looks after that. (R. 539.)

(Redirect examination)

Peppers bridge is in Washington, 1½ miles below McCoy bridge. I use wells for irrigation most generally from about July 1 on. I use electric power. Costs about $25 to $30 a month for our motor. I have three and have paid as high as $73 a month for three of them. I used wells as quick as I could get machinery on them. I didn't need to pump so much then as I do now. I had a better water right. (R. 540.)

I could go up river at nights then and I can't do it any more. When water master came on, that cut off my regulation. I didn't get up the river so much. I had to dig more wells. (R. 541.)

(Recross examination)

Pumps are on windlass platform to raise and lower with rise and fall of the water. (R. 542.)

Elba Rogers

Elba Rogers resides 1½ miles north of Freewater on highway, three-fourths mile west of Tumalum. Came to this country in 1883. (R. 543.)

I was then seven years old. Remember Tumalum from about 1890. Like any kid I was fishing and swimming between Nursery and McCoy bridges, and in July and August there was no fishing and swimming over there. We had to go down to the McCoy place to find any swimming. There was no water; it was dry. The first year I remember was 1889 or 1890. Outside of a rain heavy enough to cause quite a flow I never saw the time in July or August that there was any water ever passed over that bar. (R. 544, 545.)

They used to make roads of straw and manure across the dry bed. Stream bed was not as wide between banks as now. Stream changed from place to place, leaving rock bars. (R. 546.)

Just below railroad bridge about one-half mile, the water would disappear. In that stretch, for a mile below the railroad bridge, water sinks more than it does down toward McCoy bridge. My father and I worked up at the divide of the Tumalum into the Little Walla Walla. The first year my father worked there was 1884 or 5. (R. 547.)

The river has a habit of washing out the main river and filling the mouth of the channel that comes our way with gravel, which has to be taken out and a little later on it has to be dammed to turn the water into the Little Walla Walla. I have helped do that many years. The first year I remember working was '90 or '91. (R. 548.)

Raking out the channel and putting in the dam would be done three or four times a year. There was no measure-

ment. Sometimes the east siders would knock out the dam and we would have to go back the next day and put it in. (R. 549.)

On my place, instead of digging a well we tapped some seepage by a wooden box, afterwards changed to tile, brought it to the top of the ground for irrigation. This seepage started about three days after irrigation started above there. Do not use it now. (R. 550.)

The effect of irigation is to cause the wells to raise, and later in the season when the evaporation is so great, the wells decrease. The wells start to rise after they start to irrigate. I have a well which I keep for insurance, to use in case of need. I don't use it very often. It is 108 feet deep. (R. 551.)

The well is dug 38 feet and drilled the balance of the way. At first there will be 7 to 10 feet of water in the dug part, and then after I start pumping I soon pump down from the drilled hole. The soil beginning at the top is about a foot, then there is gravel from 8 to 12 feet and then there is cement gravel. After you get down 2 or 3 feet, clear down to the cement gravel, there is hardly any soil, it is porous. (R. 552.)

My well does not reach through cement gravel. There are places in the cement gravel we call veins that are full of water. In spring, water stands in our curb above the top of the cement gravel. (R. 553.)

If I stop pumping after the water is below the dug well, it will fill up again in two or three hours. My pump throws 165 gallons a minute. (R. 554.)

After water master took charge and began to regulate irrigation water, I had to drill well deeper. Cutting down surface irrigation shortened the water supply in my well. (R. 555.)

I raise principally tomatoes. Set them out last of April or first of May. Start to irrigate towards the last of May.

Rather not irrigate much during bloom time. First fruit sets in May. (R. 556.)

After I start to irrigate, for several years we were on a 4-day rotation which was too long, so we cut down to a 3-day rotation, which comes about right. I use 1½ inches per acre. My ditches are one-half length of my 5-acre tract, 20 x 80 rods. (R. 557.)

I have raised tomatoes since 1906. Start picking them between first and eighth or tenth of July. Harvest for general market lasts till about sixth to eighth of August. (R. 558.)

Canning and home consumption tomatoes then are harvested up to first of September. I raise about 600 lugs of 50 or 60 pounds each, per acre. My 3½ acres produced $2,786 gross one year; about 75 per cent was net. (R. 559.)

Water is measured to me across a 40-acre tract. Water master turns me 1½ miner's inches per acre. (R. 560.)

If water was cut down I simply would have to quit the tomato business. Don't leave enough water in the heat of the season as it is. The rocky soil furnishes more heat. The rocky places hold less water and store up heat in the daytime and sometimes get too hot if you do not have necessary water. Gravel belt is clearer of frost than any other section of the Walla Walla Valley. The first effect of shortage of water that we notice is withering, then two or three days after that, we notice the fruit is smaller as it ripens. The smaller fruit goes into seconds and then culls, because too small for market. The amount of water heretofore received in order to keep tomatoes up to first grade is necessary. (R. 561, 562.)

Our tomato crop comes at the tail end of the California crop and earlier than other places in the Northwest. This gives us a big advantage as to market and prices. (R. 563.)

In irrigating my land, I take eight rows at a time. I get over my land in 24 hours, that keeps us irrigating night and day. We apply water 24 hours out of each three

days, except about an hour every third irrigation to a small grape patch. (R. 564.)

In irrigating there is a little run off. Sometimes enough for my neighbor below to use it. Other times not enough. It is all used and none wasted. I have put up greenhouses. Invested better than $6,000 in them, to supply plants for myself and others. (R. 565.)

About 100 acres in tomatoes this year. Last year about 300 acres. Average yield is 500 to 600 lugs per acre. Roots go as deep as you plow your ground, no deeper. I aim to plow my ground 10 inches. (R. 566.)

District is especially adapted to tomatoes. They sell for about $1 per lug. Average return of $400 per acre. Acreage will increase when people can buy. I need an increase of water over 1½ inches per acre for the last two weeks of July up to August 8th. It would produce better fruit. (R. 567.)

We need more water because at first of season ditches are fresh. Water can seep in better. Later we have more fruit, tromped ditches, hotter weather, more evaporation. I believe during that time we should have 1¾ to 2 inches per acre. (R. 569.)

Crockett branch from N½ of section 26 on north is dry during irrigation season. The Ford branch at the lower end also goes dry. (R. 570.)

(Cross examination)

By rotating I get a head of 4½ inches per acre for 24 hours every third day.

When my time comes, I irrigate continuously for 24 hours, day and night. Ditches are 3 feet apart, and run not quite 40 rods. Our head ditch, laterals, tail ditch and turning ground would cut off 2 rods, one rod on each end. Our lateral comes out at one end, another in the center. When we irrigate, we take 8 to 10 rows on east side and the run off is caught in tail ditch and carried to west side to irrigate 3 or 4 rows. (R. 572, 573.)

Acreage increased up till last year and there was a decrease. When I came on place I was $29 in debt and had nothing. I have made that place since, all off of the place. (R. 574.)

Our tomatoes are not earlier than Kennewick. We should have same amount of water in latter part of season as the early part. Begin to irrigate in May, and continue till crop is harvested. Growers for the cannery picked into October last year. I get water from West Branch of Crockett. (R. 575, 576.)

I have a well. Some years don't use it. Last time was 3 years ago. Well is curbed for 8 feet, 30 feet not curbed. Cement gravel is just as solid as curbing (R. 577.)

Above cement gravel it is pure gravel for first 3 to 5 feet, thence from there on up there is more or less soil in it. I dug my well in 1912 or 1914. (R. 578.)

At first my well was dug 16 feet, thence to 38 feet, then drilled to 66-foot vein, and then to 108 feet. I haven't noticed any difference in the average water level in the summer during the last five years. (R. 579.)

(Redirect examination)

Water was left in Tumalum at division point to go down for east side. (R. 580.)

They would take all of the water that was left. (R. 581.)

Charles Schwald

Since 1891, lived on farm 2¼ miles north and ½ west of Freewater. Farmed McCoy place at McCoy Bridge in '92 and for 3 years thereafter. McCoy place is on east side of river, my place is on west side about two miles from river. I crossed river in front of McCoy house from '92 on. The river was dry; went dry around first of July. Also crossed river for 10 years peddling fruit. Crossed at Van Slykes ¾ mile south of McCoy place, sometimes daily, sometimes weekly, during this time. In summer time, river was dry. Water starts to run again late in the fall, about October. (R. 584, 585, 586, 587, 588.)

I worked up at dividing point of Tumalum and Little Walla Walla, first in 1891 and continued until after water master took charge. I had charge of division of water at the dam for more than 10 years, put in the dam and took care of it. That began about 1902. (R. 589.)

The mill put in 30% of the work, the farmers 70%. We always took half from the river under the bridge. The mill race was not counted in. The balance went to the east side. (R. 590.)

After I quit peddling fruit, I visited friends across the river twice a month. From 1892 to present time Tumalum was dry in the summer time. Lower end of Ford was dry from 1891 to present time. (R. 591.)

Water begins to raise in springs in Ford branch ½ mile below my place. (R. 592.)

(Cross examination)

When I had charge of the division, I represented the Walla Walla Irrigation Union, a corporation composed of farmers. I have 10 acres permanent water right and 90 acres surplus water right. (R. 593.)

Alta Rogers

Lives one mile North of Freewater and a quarter of a mile west of the State Highway. (R. 595.)

Lives three-quarters of a mile west of the Tum-a-lum. Came to the county in 1882. Was born in 1878. First knew the Tum-a-lum when ten years old, in 1888. Went swimming there and played along the river and went fishing almost daily there when young. Since he has been in business for himself he has been along the river more or less. From the Nursery bridge to the McCoy bridge the river went dry in the summer from the middle of June to the middle of July. (R. 596.)

River staid dry until the latter part of September. The bed of the river through that stretch is gravel and loose rock; cobble stones without soil content, and that condition

extends for one and one-half miles North of the Nursery bridge. From there on there is some soil mixed with the rocks. (R. 597.)

In the rocky stretch, all water that comes down during the summer sinks. He has known the Crockett branches and the connecting channel between them, and the East Little Walla Walla ever since he lived there. Before the water was adjudicated the older rights above took all the water, and those near the lower end of the stream did not get any. At the lower end the connecting channel went dry. This has continued since 1888, or 1890. (R. 598.)

After the water master went on, the water flowed better to the lower users, but no water went past and into the East Little Walla Walla in the summer time. (R. 599.)

The connecting channel between the Ford and West Little Walla Walla went dry near Charlie Schwalds place and was dry until the point where the springs rose in the channel, and this continued from 1890 down. (R. 600.)

I irrigate 15 acres. Along about 1890 I used to go with my father, C. D. Rogers, to work at the divide between the Tum-a-lum and the Little Walla Walla. From then on, every year to my knowledge, the water was diverted into the Little Walla Walla. I would judge about one-half of the water was diverted. We left enough water to run down to the east side. Before the water master went on the older fellows farthest up the streams took what water they wanted, and those at the lower end had none. (R. 601.)

They used more water before the water master came on than they did afterwards. (R. 602.)

I raise apples and have been in the tomato business for a good many years on another tract of ground. My home place is 15 acres. I have farmed it since 1913. My trees are 20 years old. I have 5 acres of Delicious apples which are 12 years old. I have a main-head ditch across the upper end of my ground. There are ten acres of my land that is 80 rods East and West and 20 rods North and South. My land lays in an "L" shape and 5 acres is 40 rods East and West

and 20 rods North and South. From my head ditch I have a lateral that comes out and covers every two tree spaces, which is 8 ditches. I take it out of the head ditch into these laterals, run it through 8 ditches, catch it on a piece of ground North on the ten acres, and use the tail water on that so as not to waste any.

My ditches are just 20 rods long. My land slopes four feet to 320, with about a four foot fall. The reason I know this is that I built a levy to run water back to my well, and I had to raise it four feet to go 420 feet. There are two or three places in my orchard that are good ground, and on these I have to put in checks, but most of my ground is rocky and I use no checks there. (R. 603.)

It takes three or four days to get over my place at an irrigation. I don't leave the water running. As soon as I get through my rows I change it into others. I have water for ten acres and run a two-inch pump. (R. 604.)

My period of rotation is three or four days. I have an inch and a half to the acre for ten acres, but in July and August it is always an inch. I rotate with the man above me. He gets it two days out of the week, and I get it five days. When irrigating my land I get the head of water that would be coming to him. He has five acres. We have 32″ altogether, besides what I pump. (R. 605.)

It takes from one to two hours to get through my 20 rod rows. Sometimes three hours in the rocky part. The hot weather in the summer time makes a lot of difference. The hot weather causes greater evaporation in the rocky land. I use a cover crop of alfalfa. I spring-tooth it in the spring and try to keep the weeds down. I let the alfalfa grow all summer and never cut it because it saves the moisture by leaving it. I do not use a rolling cutter upon mine, although most people do. (R. 606.)

I spring-tooth in place of using a cutter. By spring-toothing I work the top ground into the soil and that makes more humus, and makes a mat of the plant growth which takes the place of a mulch. The method of growing a cover

crop without harvesting it is general in the community, and is accepted as the proper method of operating the orchards. It has been tried otherwise, but if the crop is cut it is detrimental to the orchards and harder to irrigate. The cover crop is a material saving of water.

My well is 43 feet deep, and is a dug well. (R. 607.)

It is six feet square. There was about twelve feet of loose gravel on top until I came to the cement gravel. About three feet of the loose gravel had soil mixed with it; the balance is loose and must be curbed in order to keep it from caving in; it has no soil in it. The cement gravel is solid and will not cave. Water seeps through the cement gravel in veins. (R. 608.)

When I dug the well I had to shoot the cement gravel. When I went on the place in 1913 the well was there, and was 20 feet deep. About 1916, 1917, and 1918 I deepened it several times, but did not get entirely through the cement gravel. In the spring of the year when they start irrigating the water raises in the well to the curb, and within ten feet of the ground. In the winter time the well is dry. It has been dry now for three months. (R. 609.)

The water is just starting to raise in the well. They have started to irrigate above me, and if they all started to irrigating, the water would raise to within ten feet of the top in a week's time, but when only a few start it takes longer. I usually start pumping in May. I pump for the 5 acres, and to supply any deficiency in the water for the 10 acres. I mix the well water with the creek water. (R. 610.)

Pumping lowers the well, but this is not noticeable until the latter part of July or August when the well gets pretty low. I never have pumped the well dry, but in 1930 I could see the foot valve for a month; that was a dry year. I use electric power. I judge my well throws 125 gallons to the minute. My power bill runs from $25.00 to $30.00 per month. (R. 611.)

There are water users near me and adjacent who irrigate through the whole season. I don't get my 1½ inch of water to the acre throughout the year. It is cut down in July, about the middle of the month, and I must then use my pump to supplement my supply. I can't irrigate my ten acres of rocks without the pump. The 1½ inch is not a big enough head combined with the water I get from my neighbor. (R. 612.)

But by using my pump I can get along and raise crops. None of that land in and around Milton would raise crops without irrigation. Before irrigation it was bunch grass and sage brush, and would only grow stuff in the spring of the year. I grow apples and have grown tomatoes for twenty years. In raising apples I raise between 500 and 600 boxes to the acre on the 20-year-old trees; that is field boxes. (R. 613.)

I have 7 acres of Rome Beauties, and I average between 4,000 and 4,500 boxes of packed Rome Beauties; 80% fancy and extra fancy, and 20% "C" grade and culls. If I depended only upon the water from the river and without the supply from the well it would reduce the grade of my apples. (R. 614.)

Without water my apples would be small and would not color well and would make my farming operations unprofitable. I get around $1.00 a box, and it costs me 27 cents a box to raise them. Raising and packing is covered by this amount. My Delicious apples this year I sold for $1.00 a box loose. I had 2,002 boxes on 5 acres from 12-year-old trees. That is fancy and extra fancy only. On the 10 acres I can raise between 4,000 and 4,500 boxes of fancy and extra fancy. (R. 615.)

On the 15 acres I had between 6,000 and 6,500 boxes of fancy and extra fancy apples. This is near the average production for the district. Everybody takes care of their orchards about the same. After they start irrigating, the water in my well raises rapidly. The water comes on top of the cement gravel as near as I can tell. (R. 616.)

The water starts in at the very bottom of the well, and apparently from the veins in the cement gravel, because I could see it if it ran down the well. It does run down the walls later on. The irrigation water goes through the veins. (R. 617.)

CROSS-EXAMINATION

Water flows through the connecting channels between the Crockett and the East Little Walla Walla during the fall, winter, and spring. The channel goes dry during the dry season. There are springs coming out below the connecting channel. The same is true of the connection channel between the Ford and West Little Walla Walla. (R. 618.)

The connecting channel between the Ford and West Little Walla Walla goes dry in the summer time, but water runs during the fall, winter, and spring. I have a cover crop of alfalfa between the trees. I re-sow this when it gets old. I have missed spring-toothing it some seasons. I spring-tooth it in the spring of the year, and prepare my small ditches if I spring-tooth it, and clean these ditches twice during the summer. (R. 619.)

I have seven (7) acres of Rome Beauties, 3 acres of Wine Saps, and 5 acres of Delicious. Last fall my apples brought a little better than $1 per box. The two years before that I lost money. Taking the seasons all the way through they will average a little better than $1 per box. (R. 620.)

The water master drove a nail in my board and told me that is where my water should stand to get my inch and a half of water, but in July and August it is never up to that nail.

The majority of the time I get two-thirds of my allowance. After I begin pumping I run my pump continuously day and night. It is not cheaper for me to run my pump all the time, considering the labor cost of shutting it off.

If I could shut it down part of the time I would be better off. I don't shut it down because I need the water. (R. 621.)

I run eight rills at a time. My Rome Beauties are 25 feet apart; my Delicious 25 by 30 feet; my rills run in a 25 foot width, and are 2½ feet from the trees, the nearest ones. I run four rills between each row of trees. I used to run five rows, but my water was too short and I had to cut it down so as to make it two rills on each side, and cut out my center ditch because I did not have water enough to get through in July and August. (R. 622.)

I have a catch lateral, but I cannot irrigate the 5 acres with the water from the 10 acres. I catch two or three ditches of the 5 acres; where I irrigate eight rows I catch two or three rows at a time below and get part of my orchard irrigated that way, and when I turn my water on the lower land I don't have so many rows to irrigate. When irrigating, I irrigate at night as well as day. I usually change the water about 10:00 or 11:00 o'clock at night and then about 4:00 o'clock in the morning. (R. 623.)

I have some places where I get through my runs quicker than two hours and some places not so quick. I change the water the last thing at night before I go to bed from 10:00 to 11:00 o'clock, and I haven't missed a changing at 4:00 o'clock in the morning more than ten minutes at any time. I irrigate so that it takes me three to four days to get over the 15 acres, and as soon as I finish the last part, I start immediately upon the other part, and I am irrigating continuously. (R. 624.)

There are periods when all of my water but the well goes to my neighbor for his use.

West of Freewater there was quite a little ground not in cultivation when I was a small boy. Some of it has been brought into cultivation since I can remember. There is no increase of acreage in apples in my neighborhood in the last five years. Some apples have been pulled out. (R. 625.)

RE-DIRECT EXAMINATION

If the water for the trees is short one year that affects the crop for the next year, and if very short it would affect it for several years, although I do not know this for sure. Where the trees have been pulled up most of them are growing tomatoes. Through the gravel belt we are pretty safe on frost. (R. 626.)

I have seen crops killed by frost on good ground when we had a full crop on the rocks. I believe the rocks get warm in the daytime and stay warm half of the night. I have seen frost at the state line on the good ground, but the sun shines in clear weather when frosts come at night, and warms the rocks and they stay warm until midnight. I have picked up the rocks and they are warm. (R. 627.)

RE-CROSS EXAMINATION

There are plenty of rocks on top of the soil, and I believe that it is these rocks which help with the frost.

When there is moisture in the soil we are a lot more subject to frost. I think the rock warms up the soil rather than the soil cooling the rocks. Keeping the temperature up late in the evening makes the warmth last longer in the morning. (R. 628.)

Testimony of Jas A. Fee

(630 to 635)

Lawyer since 1894. Lived in Walla Walla before 1884. 1880 on. (R. 630.)

Business took him to Walla Walla. Crossed at Ford by McCoy place. First crossed in May or June, 1885. (R. 631.)

Crossed again after the middle of July or middle of August both coming and going from Pendleton. Had been water when I crossed before, but it was dry then.

Crossed several times in dry season of 1885 and 1886. Never saw water there in dry season. Dry in July or

August, 1885, and again in 1886. Helped try Finis case. (R. 632.)

Never down by McCoy place again. When crossed it was right by the house. McCoy and I read law together. Do not know about 1895 to date. (R. 633.)

CROSS-EXAMINATION

McCoy buildings now in substantially same place. (R. 634.)

Came from Walla Walla buildings on left as I crossed the stream; there was open roadway there. (R. 635.)

Testimony of Warren Roeder

(636 to 677)

I live 1¼ miles North and a little West of Freewater. I came there in 1913 as Assistant Water Master. L. A. Rieneman was Water Master then; he is now in California. I took up distribution of water on Walla Walla River in Oregon. (R. 636.)

I distributed under Finis Decree (Oregon Ex. 31). Worked as Water Master to 1919, and at all times distributed under decree. I went on in the Spring of 1913, and became familiar with stream system. (R. 637.)

I went on in April but began studying stream in March. There were wooden divides and headgates of different patterns, but no established system. There were holes around and under and cracks in the wooden gates; cracks in weirs so there could be no accurate measurement. That year (1913) the Tum-A-Lum was dry and has been each year since. (R. 638.)

From the point in the Northeast Quarter of Section 26, where the two Crocketts came together to where the springs rise for the East Prong the channel was dry.

From the line between Sections 25, 36, 35, 26, 27 and 34 in 6 North 35, there was practically no channels—1½ feet in places—they would narrow to 1½ feet. Willows, alders,

and brush grew 4 to 20 feet aside from the channels. (R. 639.)

The Ford was the same. The Crockett, the Ford and all channels were dry at the end. We dried up the Tum-A-Lum.

In the summer no water went down either Ford or Crockett to Washington. The men at the ends of channels dammed the streams with dirt and manure so no water went past.

The same condition has existed each year since. (That no water went to Washington in the summer time.) In the winter the water ran to where these channels narrowed and then flooded out on the places. (R. 640.)

The place I bought was a lake each winter and spring because the channels were so small water could not get through. We straightened the channels. They thought brush growth saved evaporation. After we got in divides and "proportioned" water they opened channels and took out brush. Channels were moved to property lines and made from 3 to 4 times as large. (R. 641.)

Even today when it rains we have floods over the tops of these channels. We would have to increase the channels to carry water to Washington. We put in the frog when I first went on before then there was just a plank. The frog is in the Northeast Corner of the Southeast Quarter of the Northeast Quarter of Section 2, 5 S. 35. We put it in with concrete and gates. (R. 642.)

In measuring at the frog we had to allow for seepage. (R. 644.)

The first year we spent two days a week checking seepage and evaporation. The first year we allowed 15 to 25%, and in later years we reduced this to 10 to 15%. In cloudy and rainy weather there is less loss by seepage and evaporation. (R. 645.)

I got in the last main divide the year I left. (R. 645.)

We could only get in 2, 3 or 4 in the Spring, and 1 or 2 in the fall. We put in the Overturf divide in the Fall of

1919. During all my time there it has been a gradual development in distribution and putting in divides. (R. 646.)

At the Red bridge, when I went on we would go up and scrape out and put in a sack dam. When I went in we shut off the water as tight as we could at the Red bridge, and then we supplied whatever the East Side was short by turning it out at the spillway in the Peacock Mill race. (R. 647.)

We took all the water out of the main stream and put it into the Little Walla Walla. After that we turned none down for Washington. If the East Side dam was not proper we turned in no water for them. (R. 648.)

Our system limited the old rights to 1½ inches per acre. They had been using more. (R. 649.)

When I went on they were getting as much water around and under the weirs as through it. There was only one concrete headgate on the system (Stillman) when I went on. I bought my place in 1917 and have farmed there since. I have 15 acres now; had 20 and let my cousin have 5 acres, but I run the 20 acres yet. (R. 650.)

My 15 acres varies from good to extremely bad soil. It is volcanic ash, washed in by the stream, and underlain with gravel. I raise cherries and prunes. (R. 651.)

On the 20 acres there are 14 acres prunes; 6 acres of cherries; (one acre out for buildings and roads); making about 19.3 acres.

Cherry orchard to south 30 x 32 rods divided in center by head ditch and tail ditch. The prune orchard is 46 2/3 x 48 rods divided in center by a tail ditch and head ditch. I turn all the water on upper end of cherries, then pick it up in tail ditch, run it on lower half of cherry orchard in as many ditches as I can, pick it up again and start on the prunes to the tail ditch, pick it up again and run on the lower half of the prunes. (R. 652.)

My land falls 80 feet to the mile. I use no checks; get through as fast as I can. The soil is so porous it requires

rapid flow to get over it. In some places I must seal the ditch to get the water through. (R. 653.)

None of my laterals are over 20 rods long. (R. 653.)

In the cherries (30 feet to square) I have 5 ditches to the square, about 3 feet apart and run 5 or 6 of them at a time. In the cherries on my first run I run 25 laterals 15 rods long; 6 or 7 in the low season in the cherries and 6 or 8 in the prunes (20 rods long). The soil in the prunes carries the water better. (R. 654.)

Takes me one week to get over the place. I do not rotate; could not without enlarging head and tail ditches. When I get through once I start right in and go over it again. (R. 655.)

I have never used the well; it is insurance. Well is 35 feet deep and 150 feet drill hole. 14 feet loose gravel then cement gravel. Loose gravel does not have soil all the way down. (R. 656).

Soil is mixed with dirt from one foot to 1½ feet to 12 feet. The well at the house was sand and gravel. Very porous after 1½ feet and down to 7 feet. In 1933 measured water used on place, and turned measurements over to Water-master. I used over 2 inches from the last of March to the 1st of June. Last of June about 1½ inches. July less than 1½ inches. August 1½ inches. (R. 657.)

I use alfalfa cover crop. I didn't cultivate cherries in 1933, save in Spring. We re-run ditches once or twice in the summer depending how the grass grows. (R. 658.)

I used no fertilizer in 1933. I raised 110 tons of prunes and got a net of $16.55 a ton; this is about a normal crop. I had 12 ton of Bing cherries, 4 tons Royal Anns; and 1½ tons of Black Tartarians. I got two cents per pound on the Annes and Tartarians, and four cents per pound on the Bings. Net returns. Normal crop but low price. (R. 659.)

Cherry price was one-half of the year before, and one-sixth of the price in the two years before that. I think the average for the district would be three-fourths of my return. (R. 660.)

Much of the land lays so they can only pick up water once; I can pick it up three or four times. My system lets me raise crop with 1½ inches. (R. 661.)

If water is cut down as it was in 1931 it reduces the crop; produces more culls and the trees shed; the fruit drops off. (R. 662.)

We had better price on prunes last year. The irrigation system through the valley is now an economic system. There could be more land irrigated at a great expense by lining ditches to stop seepage. (R. 663.)

Such cost would be more than the ranches could stand. The system took time to develop because the ranchers had no money or help. Concrete work has been put in. (R. 664.)

A pipe line was built to cross a stretch where there was 40% seepage loss. If a rancher would not clean his ditch we cut down his water. (R. 665.)

Ranchers irrigating from springs would ask me when irrigation would start. They knew the springs rose after we started to irrigate. The concrete road was put in on the State Highway between Walla Walla and Milton in 1917 or 1918. The road was impassable before that. (R. 666 and 667.)

The water came out on the surface. Tiling was put in and takes the water to the Walla Walla River. Before that the water went into the Big Spring Branch. The tiling through the center of S. W. ¼ of Section 11, T. 6 N. 35, affects the supply of Big Spring Branch. The tile runs from the highway straight north to the river; leaves road at NE¼ of SW¼ and runs 80 rods to the river. Drains land in E½ of SW¼ of Section 11. (R. 668.)

CROSS-EXAMINATION

My place is on the Ford Branch. I get water from the West Prong of the Ford; it now runs around my place; did run through. (R. 670.)

In studying seepage loss we proportioned at each weir down full length of stream. We used metal strips to adjust. (R. 671.)

We spent two days a week checking weirs. Soil is generally mixed in territory. (R. 672.)

In 1913 as soon as water got short, we called ranchers and stopped off water to the Tum-A-Lum. There were outlets which carried water North in the winter. In 1913 people raise fruit, berries and crops they could get off early because of water not getting down. (R. 673.)

But few tomatoes were grown and nothing that needed heavy irrigation late in season. North of my place, there was no channel to carry water and made my place a lake in winter. Cars got stuck in the road in front of my place. When the spring rains were over the river would carry the water. (R. 674.)

High water in spring usually put bar across mouth of Little Walla Walla and water would run down Tumalum. As soon as they could get in they opened the channel to the Little Walla Walla. In 1913 but little water could get from Ford to the East Little Walla Walla. Channels were changed to provide drainage. (R. 675.)

Spillway used to deliver East Side water is one-half to three-fourths of a mile below red bridge. Now all divides are concrete; frog in concrete. Most headgates are in concrete. This makes system economical. (R. 676.)

Testimony of Aubrey E. Perry

(Transcript pages 678 to 701.)

I am an irrigation engineer working for the Central Oregon Irrigation District. I am a registered and licensed engineer since Nov. 8, 1919. (R. 678.)

I was water master (in Umatilla County) Dist. No. 5 covering three counties from April 10, 1918 to December 1, 1928. During all this time I had an assistant in the Walla Walla basin; Roeder 1918 and part 1919; My father then

worked for two years; Victor Hess in 1922 and 1923; Carl Mason then on until I quit. I made frequent trips (once or twice a week) to inspect and direct the distribution of the Walla Walla water. (R. 679.)

The greater share of my work was here. I observed the Tumalum from the Nursery bridge to McCoy bridge. The red bridge is about one mile above the Nursery bridge at divide between Tumalum and Little Walla Walla. Nursery bridge is by the Railroad bridge. (R. 680.)

East Side ditch takes out about 100 feet above the Nursery bridge. The Hudson Bay Tumalum ditch takes out just below the Nursery bridge. Each year that I was watermaster I observed the Tumalum between the Nursery bridge and the McCoy during the dry season. That stretch was dry every summer. (R. 681.)

The surface was entirely dry. The farmers every spring put in a sack dam and took all the water from the Tumalum into the Little Walla Walla. It was carried down the Little Walla Walla to the spillway where enough was turned into the Tumalum to supply the East Side. (R. 682.)

East Side took out 100 yards below spillway. East Side put gravel and sack dam in channel to get water into their ditch. Below East Side dam there was no water in the Tumalum. East Side dam is 200 yards above Nursery bridge. Channel was entirely dry below that point in July and August. (R. 683.)

Under the Finis Decree (X-31) we delivered East Side 1½ inches to the acre. During all the time I was watermaster I administered Decree which is X-31 in this case. (R. 684.)

I studied seepage losses in all the streams while I was watermaster. (R. 685.)

(Testifying from 1918 report) The Ford (all branches included), on down to Schwald's place, two miles from the frog, a total stream length of 4 miles in July, while irrigation was going on and all the water in the stream was being

used for irrigation there was a loss of 32% or 8% to the mile—a main channel loss. (R. 686, 687.)

The Crockett branches run close to the Ford in the same soil and territory. The loss in Crockett's I figured many years; it never varied much; was 20%. (R. 688.)

The average loss was 8% per mile. In June, 1928, 1000 inches were turned down the Tumalum channel. (R. 689.)

I followed it down; it ran 3 or 4 days and never got past one-half mile; never reached the McCoy bridge. (R. 690.)

Once or twice in 1918 or 1919 flash boards were off Hudson Bay dam for a day or two. I observed connecting channel between Ford and Spring branch. (R. 690.)

That channel was dry during irrigation season in the summer. I observed Crocketts and connecting channel to Spring branches below and channel was dry in the summer each year. Above Milton river is in steep narrow canyon; sides and bottom are rock; thin layer of soil and gravel on basaltic rock in bottom. (R. 691.)

Bottom is solid basalt rock. August 3, 1927, checked return water from irrigation in upper river. One and one-half feet seepage thru P. P. & L. dam and we turned two feet more down. This water was all diverted and seeped back into the channel and supplied all the lower users on the upper river. Each user took all he could from the stream. (R. 692.)

Each user dried stream; took water and used it and below him a similar amount was found in the stream. This covered six miles to Milton Power plant and supplied the rights. Very little consumptive use. (R. 693.)

It revived the prunes. Under Finis Decree 1½ inches of water was fixed as duty delivered at the land and I delivered that amount. Ford and Crockett were natural channels and each diversion was from a natural channel. (R. 694.)

Most farmers took water from the stream right on their land. I never turned the water down the Tumalum during any season at the request of Gardena for their use. They

never demanded it. The conditions when we studied losses in the Ford and Crockett were different than in November, there would be more evaporation and seepage. In November there would not be much irrigation. (R. 695.)

CROSS-EXAMINATION

My testimony on Crockett losses covers studies made in all years up to 1928. The total was from 15 to 20%; 8% per mile. (R. 697.)

In the upper stream rock is exposed clear across the stream. (R. 698.)

In the seepage study on the upper river the water was used up when it reached the power plant. (R. 699.)

In that stretch (during very hot weather) the water was used up, but went that far. There was only return water because before we turned the additional amount down there was no water in the channel for 1½ or 2 miles, the 3½ feet was used up over the stretch. (R. 700, 701.)

Aubrey E. Perry

(Transcript pages 853 to 861.)

None of the irrigation wells furnish water for land other than that of the owner of the well. All of the pumping operations are for irrigating the over-lying lands owned by the well owners. (R. 854.)

As watermaster I noticed that the Tumalum river was turned dry when the gaging station (No. 212) was between 185 and 200 feet. When that amount of water was at the gauging station, all water flowing in the Walla Walla river was diverted and the Tumalum was dry. That station is about five miles above the Nursery bridge. Not all of the water was diverted into the Little Walla Walla at the divide; some went to the East side ditch and to the Hudson Bay, but the Hudson Bay was taking all the water in the channel at that point. (R. 855.)

I investigated the depth of gravel and soil above hardpan near the stream of the Tumalum river where it runs

dry, by examining wells, and the depth of the piers of the railroad bridge which crosses the Tumalum. This bridge is about 50 feet up-stream from the Nursery bridge. The west pier sets on hardpan, and it is 18 feet to hardpan from the river channel; the east pier has a depth to hardpan of 20 feet. These piers are right on the edge of the bed of the stream. (R. 857.)

The John Clark well, 100 feet north and 100 feet east of the east end of the bridge is 19 feet to hardpan. It is in the NE¼ NE¼ of Sec. 1 Twp. 5 N. R. 35 E.

The H. M. Betts well in the NE¼ NE¼ of Sec. 1, Twp. 5 N. R. 35 E. is 1,000 feet west of the bridge and is 14 feet to hardpan.

The Todd well is 600 feet east of the channel, and the hardpan is 20 feet below the surface. (R. 858.)

The Bostwick well in the NW¼ NE¼ of Sec. 36 Twp. 6 N. R. 35 E. is 1600 feet east of the channel and is 10 feet of loose gravel, then 8 feet of clay to hardpan. The Jerome Hill well in the SW¼ SW¼ of Sec. 25, Twp. 6 N. R. 35 E. is 1600 feet west of the channel and is 15 feet to hardpan.

The N. H. Hayden well, in the SE¼ SW¼ of Sec. 25, Twp. 6 N. R. 35 E, is 600 feet west of the channel and is 10 feet to hardpan. This is above the McCoy bridge and on the west side of the river about one-half mile above the McCoy.

Right opposite the McCoy bridge is the Pete Miller well, 900 feet west of the McCoy bridge on the section line between Sections 24 and 25, Twp. 6, N. R. 35 E., and is 33 feet to hardpan, but sets on a raise just above the channel about 15 or 16 feet. (R. 859.)

CROSS-EXAMINATION

There was that much water at Station 212 when the water stopped flowing about five miles below the station, and all water from the stream was diverted either at the Little Walla Walla divide or the Hudson Bay intake and the east side. (R. 860.)

My data on the wells were partly obtained through the last year and partly during the time I was watermaster. The Clark well I measured some years ago. (R. 861.)

RE-DIRECT EXAMINATION

Station 212 is below the forks and would give the combined flow at stations 214 and 216 less diversions above station 212. (R. 861.)

Testimony of W. E. O. Criger

(Transcript pages 702 to 713.)

I am a Civil Engineer; registered and licensed in Oregon; followed the business 23 years. Surveyed Gardena old ditch in 1933. (R. 702.)

Had Or. Ex. 34 and 35 and could determine the line of the old survey. Surveyed the ditch line outlined upon them; checked courses and traversed levels along the whole length. Found old survey stakes along whole length. (R. 703.)

Prepared map. Ex. 37. "End of Water" was the end of live water in the ditch; "End of Ditch" marked end of old construction. "Old Stake" indicates some of old survey stakes found; there were too many to record and they were quite frequent. (R. 704, 706.)

Dotted line west and south of hatch marks shows level to which water could have been taken by the old ditch. Hatch marks show land now irrigated which could not have been irrigated under the old ditch. Map drawn to scale. Small figures in hatch marks are acreage. (R. 707.)

CROSS-EXAMINATION

Map of gravity flow. (R. 709.)

Gardena is 60 or more feet above nearby water courses. (R. 711.)

RE-DIRECT

Fall 2½ feet to the mile. Checked ditch above end of water and it carried that fall. (R. 712.)

Testimony of W. C. Mason

(Transcript pages 714 to 741.)

I live 2¼ miles north of Freewater. Farming. Deputized on part of Little Walla Walla in 1921. 1923 to date as deputy water master. 1923 to date in complete charge locally of distribution of water on Walla Walla. (R. 714.)

Spencer is now the watermaster in charge; before that Perry was the water master. We usually start regulating the stream in May and June. The years are different, but we start when they begin irrigating generally. First we set weir boards and regulate headgates. (R. 715.)

Have charge of distribution on upper stream. The west bridge is a mile below the joining of the North and South Forks. We make pretty careful adjustments below the West bridge, but although we are subject to call for regulation above the West bridge, we have very few calls. I find that the use of water by the irrigators above the West bridge does not interfere with the general stream system. There is a lag when they first make their diversions, and we have tried to encourage an earlier use so as to not have the lag during the critical period. (R. 716.)

The lag is very noticeable for three or four days after they first divert on the upper stream. I was with Perry in 1927 at the Power Company's plant. Before that the Power Company's flume was leaky and enough water got into the stream for the irrigation, but along in 1926 or 1927 they tightened this flume and checked the leaks. (R. 717.)

In 1927 the tightening of the pipe line prevented the leaks, and there was not enough water. We turned down over the Power Company's dam an additional two-second feet. Each diverter used a manure or dirt filled dam and took all the water they possibly could from the stream, but a great many of them did not have enough water at their property line to take care of their rights. With the two-second feet we turned down there was a total of 3½ second-feet to supply them. (R. 718.)

I checked for springs and found a few small ones with probably a tenth of a second-foot leading in out of some of the canyons. The rest of the water came back within a quarter of a mile of each diverter's dam into the river again. The stones and rock were large along the banks, and the banks were very steep. The ditches were usually close to the stream, and resulted in a heavy percolation back into the stream. About 25% of the amount diverted reached the property line. I judge about 75% returned to the stream. I measured it both at the intake and the property lines whereever possible. I got the water to the Paulsen place, which is the lowest place before I got it to the Jarrard place. (R. 719.)

Below the West bridge and above the intake of the Milton ditch there is a headgate system on the Zell ditch. The Spence ditch has a weir; both have spillways where we can turn the water in the ditch back to the river. (R. 720.)

The Zell ditch had one-eighth of a mile of their ditch washed out entirely, and that condition exists in the Canyon generally. The irrigated tracts are small and the amount diverted is small. We do not require them to install permanent diversion works along there. (R. 721.)

The changing character of the stream and the banks is one reason for that. When the river recedes I go on the upper river, check on the quantity used, and regulate their headgates in that particular section. I usually regulate it at the spillway. On that section of the river it is almost impossible, without an enormus expense, to keep anything that would withstand the river pressure; it would cost more than a small irrigator could invest. (R. 722.)

In June 1927, a freshet came down the river in a twenty-minute period and raised it 1,000 second-feet in twenty minutes. Before that 1,000 feet came down it have been flowing 125 second feet. It was just after the Hudson Bay shut off. Part of that run-off was down by morning, but it was several days before it was all down. It washed out all the dams.

I know the diversion point of the Milton ditch. It takes out in an old channel. The river has been very changeable at that point in the period I have known it. (R. 723.)

It has caused the city a lot of expense and trouble to keep the river from cutting down the southwest bank. The Milton ditch proper starts in at Thorne Street in Milton. Above Thorne Street the water is carried in the old channel and the flume which the ditch company and the irrigators put in. This is about three-quarters of a mile above the Thorne Street gates. But the point at Thorne Street was originally the intake from the stream and the measuring works have been there ever since I have been on duty. The Milton ditch has a headgate at Thorne Street and a pass ditch leading back into the channel. (R. 724.)

The passway empties into the Miller flume. The discharge from the Miller flume is into the Little Walla Walla. All of the surplus water diverted to the Milton ditch and turned out their spillway goes into the Little Walla Walla. Since I have been on the stream I have watched the Ford and Crockett branches. Their water is taken out at the frog. (R. 725.)

We allow between 15% to 20% for seepage loss. In the spring there is not so much loss. When the weirs are put in it increases the loss. (R. 726.)

When diversion dams or weirs are placed in the channel of the stream that reduces the carrying capacity of the channels. We have put in proportionate weirs because of fluctuations in the stream, and it makes the most equitable distribution. They are rectangular, contracted, proportionate weirs. (R. 727.)

Dr. Woodburn made his seepage test upon the Crocketts in November and December. Most of the weirs were then out. I have known the Tumalum since 1901, in the fall. Each year from 1901 down to the present time it has been dry in the summer time. I have crossed the river back and forth every year. I have seen it dry in the middle of May and have seen it run as late as the forepart of July. (R. 728.)

As a rule it stayed dry until the heavy fall rains set in, around the latter part of October, and after irrigation is over with the exception of the Hudson Bay Ditch Company, which practices winter irrigation. In 1933 at the time irrigation stopped, or about that time, I followed the water turned down the Tumalum river to see how far it would go. 19 feet turned down on October 31, 1933; 21 feet on Nov. 1st, and 25 feet on November 2nd only reached between a quarter and a half mile below the Nursery bridge. (R. 729.)

The 240 feet which came down on November 3d reached the state line about 9:30 in the morning; or rather on Thursday morning of November 3d had not reached the McCoy ranch. On Friday morning the river at 9:30 reached the Walla Walla river gauge. On November 3rd, at 9:30 in the morning there was a heavy rain that came and washed out a dam or two above. It took out the Mill Company's dam and 200 and more second-feet went down and cleaned out everything along the river. October 29th and 30th there was 8 second-feet went down, and that did not reach a quarter of a mile. (R. 730.)

Two or three times I saw where someone had torn out the flash boards on the Hudson Bay Company's dam from two to three to five hundred miner's inches would flow down, but no part of this ever reached through the dry stretch. At one time I recall I followed it down when 500 inches were flowing, but the water never got to the irrigators below. In 1928 some water was turned down. I did not follow up this water to see if it went through. I know the channel that connects up the Crockett branches with the East Little Walla Walla. It has always been dry during the irrigating season since 1901 to my personal knowledge with the exception of 1918, which year I am not familiar with. The same is true of the channels which connect the Ford with the springs at the head of the West Little Walla Walla. Whenever we discover waste I cut down the irrigators head of water until they change their system in order not to make a wasteful use. (R. 731, 732.)

I would remedy waste immediately in all cases. We do not attempt to prevent waste when the Tumalum river is full and thousands of inches are running into the Columbia. During the high water time we encourage the use of water without limitation so as to get water into the gravel to feed the wells and springs. We check up on the irrigators throughout the season. (R. 733.)

As a usual thing both myself and the irrigators keep a check as to the amount of water they get. (R. 734.)

A large number of irrigators follow the practice of a limited rotation. When they raise nothing but orchard on the gravel land we can sometimes rotate along 50 to 60 acres; but where they have tomatoes a 20 acre rotation system is the most satisfactory, and is the largest we could put on. They have tried larger, but have been cut to very short periods of running, resulting in injury. The Rogers tract is about an average size in the tomato line in the real gravelly section. (R. 735.)

The rotation as practiced is a reasonable method, under the conditions and circumstances in that particular district. I, personally, lost $200 on a bean crop because of the attempted diversion and rotation with a large number. We are very subject to rises and falls in the streams in May and June. We have drops as high as 25 second-feet in a day, but as a general rule in the last part of June and first of July the sudden rises and falls of the stream comes more in May and June, when the warm winds are blowing and there is hot weather. We get as high as 25 second-feet drop per day. The Hudson Bay priorities are 1903, and its time of shutting off varies from the first part of June until the first part of July. The earliest time was around the 25th of May, in 1926. (R. 736.)

CROSS-EXAMINATION

The P. P. & L. Co.'s dam diversion point is from 16 to 18 miles above Milton, and is considerably higher than Mil-

ton. The fall in the canyon is somewhere around 80 feet to the mile, and the season up there is a little later. (R. 738.)

The flow into the frog is fairly constant. (R. 741.)

W. C. Mason—Direct Examination

(Pages 1135-1146)

There are approximately 160 rights which we have to divert from the natural channels. In administering water on the Oregon side the time of beginning of measurements is determined by the time the stream falls below the total number of rights. (R. 1135.)

I have a record of placing weirs on the Crockett branch on May 11, 1933, but all weirs were not placed on the Little Walla Walla at that time. That is the period when we started. My notation shows I placed the Crockett weirs then on account of danger of lowering the underboard in places with the heavy stream. The stream was too high to place the full depth of measuring weir at that time. From then on through the season we were administering and measuring water. We used proportional weirs on the different channels and we controlled the flow into the channels by the gates at the frog. The gate at the frog is where we make our adjustments so that exactly enough water goes down to take care of all diverters upon the channel. In making an adjustment on the Crockett branch to cut out priorities, it takes me about a week. (R. 1136.)

It takes at least four days to make an adjustment and cut out priorities on the Ford; three to four days. I don't always check the up-river ditches. We haven't been in the habit of controlling ditches above the Jewel West bridge. Other diversions would take about two days to adjust. If there is a rise in the stream, and if the Hudson Bay ditch priorities had been cut, and I would not have to adjust the entire priorities on the Crockett and Ford branches, it does not take long to take care of the rights—probably a three or four day period. If the Hudson Bay ditch was out it

would take in the neighborhood of nine days to adjust the entire stream. If I turn into a channel more water than is required to supply the decree rights on that channel, the over-diversion is divided proportionately among the users. (R. 1137.)

In other words if there is a surplus over the entire amount they are entitled to, and the surplus runs for a day or two, all users on that channel gets the benefit of some surplus water for that period, for whatever time the surplus ran. (R. 1138.)

During the irrigation season, all of the rights below the gravel fan and below the dry places on the Ford and Crockett branches are supplied from the springs. In the spring months before the headgates are in they get some river water before irrigation is generally started. After we start measuring water according to priorities none of the river water goes through to them. When there is a surplus in the stream, over all rights, we make no measurements to the users. During that period there is usually water running through the entire course of the Walla Walla river to the Columbia. (R. 1138.)

As a matter of administration we cannot differentiate between the soil classes upon the gravel fan and the up-river soils. The soil is so general in character it would take a very minute detailed measurement, and it seems to me would be impractical as far as distribution is concerned. With my knowledge of the territory and my familiarity with the water rights I cannot pick out on the Youngs soil map the areas of soil in each man's holding; that is the different classes of soil in each man's holdings.

We have two power plants—the Milton City power plant and the P. P. & L. Co., and these companies, especially the Milton City have fluctuating needs. Their requirements are not regular and that is one reason why it takes a little longer period to administer. (R. 1139.)

I first have to determine whether I have a head in the stream, and I have set the gates and regulated them. At first I attempted to do that three or four times a day. I found that I was very often injuring some parties, over-supplying some of them by a system of that kind. There were fluctuating heads that were coming down, and while they were not great, they changed the number of second-feet. The Milton City takes water from the main canal at about station 215 on the South Fork and they have an over-flow—one of their tail races feed back into the old city pipe line which supplies water that goes into the Little Walla Walla river. Their main over-flow, however, drops down and runs into the main channel, part of it being picked up by the Milton ditch. This increases the head in the Milton ditch in case of overflow, and increasing the head on the East Side channel or the Tumalum channel, and making necessary a change of all those controls to change that water. I have found from experience that unless there is a continued change, the best method is to leave that control alone, and there is very little damage to any party. However, if I find an over-diversion on the Milton ditch and attempt to control and regulate that at their spill-way, I quite often came back and found it one or two second-feet under-diversion. (R. 1140.)

So there are over-diversions and sometimes small under-diversions, and I find it best to leave them alone on account of it being impracticable to distribute evenly. If there is an over-diversion in the Milton ditch and water runs down past and over it, it is there picked up and used by the Finis Irrigation Company. They irrigate about 107 acres with that waste water right and their well. (R. 1141.)

Mr. Perry, Spencer, and myself made a compilation of the exact acreages irrigated through the West Crockett, the East Crockett, the Stillman ditch, the Ford branches, the East Side ditch, the Powell ditch, the Perkins ditch, and the Tumalum ditch. We checked from the decree and we

also knew who diverted from these branches. We had the old adjudication map, and our record of delivery; also a former compilation we made. We turned the figures over to Mr. Humphrey. I don't know when I started measuring water in 1932; I haven't my data with me. (R. 1142.)

In distributing water through the natural channels, such as the Ford and Crockett, we have a transportation loss of from 15 to 20 per cent. We have arrived at the figure of 20 per cent as a transportation allowance, and it approximates as near as possible the amount that carries the users' rights down to them. I know the East Side ditch. It is a natural channel which has been improved into a ditch. There were two branches and the farmers formed a ditch company, straightened those ditches out some, and formed their ditch company to transport water through the ditches. It is an improved natural channel. (R. 1143.)

In turning water down there we allowed for a transportation loss. The McCoy stock water is taken through the East Side ditch and turned into another ditch for transportation to McCoys. All rights on the East Side ditch are awarded out of Little Stream; the McCoy branch. We allowed a 20 per cent loss on the East Side over approximately a two and a half mile course. The McCoy's are awarded 50 miner's inches at the head of the stream and their carriage is nearer three miles. (R. 1144.)

MASON—CROSS-EXAMINATION

That was in accordance with the old Finis decree. The Jewel West bridge where we started regulating the stream is about four miles above Milton and in the neighborhood of four and a half miles above the red bridge. In regulating the stream for rights below we use the East Side ditch, the Tumalum ditch, the diversion at the red bridge, then there is Stillman, Perkins, and several other small users along the Little Walla Walla, and the headgates at the frog and the Powell ditch headgate. Then we use diversion weirs and

numerous small weirs up and down the East Crockett branch, the West Crockett branch, and the Ford branches. (R. 1145.)

When there is an increase in the stream and I discover it to be a definite increase, I adjust the headgates and regulate it. If I am undecided about a small three or four second-foot increase I let that go down the stream if the Hudson Bay ditch rights are out. If they are partially filled I check the difference and throw it into the Hudson Bay. Unless I determine that a head of four to five second-feet is not a fluctuation, I merely apportion it ratably among the headgates. If I know there is an increase in the stream I adjust that to the rights. We also regulate the Milton ditch. (R. 1146.)

Testimony of George Knopf

(Transcript pages 742 to 746)

I live in Oregon on the state line. In 1933 I measured the water used on my place under the direction of Mr. Humphrey, of the state engineer's office, and sent him the measurements. I measured with a rule. (R. 742.)

I did not calculate the amount of water used, myself. I used the water on three acres of orchard; prunes and apples. My soil is most all gravelly; there are a few spots with surface soil, but gravel below. I have grass; blue grass and some alfalfa—five or six years old—for a cover crop. I use the fertilizer from my chickens; I have no live-stock. (R. 743.)

I raised eight tons of prunes; there was a little less than one acre in prunes; this would be about three-quarters of a normal crop. I raised 300 loose boxes of apples on two acres; all grades combined; one-third were "C" grade and culls. (R. 744.)

I had about one-third crop of apples. I had water for the whole five acres, but used it all on three acres. In 1930

I tried to farm more and had to give it up because the water was not enough to cover it. By using the water for the five acres on the three acres I was able to raise a crop. I do not rotate. (R. 745.)

Testimony of C. E. Herr

(Transcript Vol. VI, pages 748 to 760)

I live at Sunnyside, about one and one-half miles north of Freewater and three miles south of the state line, and have lived there 29 years; I have been engaged in fruit raising at all times. (R. 748.)

I have irrigated during all of that time and have a fraction over ten acres. In 1933 six acres of my property and two acres on my father's were taken as one of the test places making eight acres under the measurement. The soil varies from gravelly to very rocky. I raise cherries, apples, prunes, peaches, grapes, plums, and a small garden. (R. 749).

Under the measured part there were close to three acres of cherries; close to three acres of apples; a fraction over one-half acre in prunes; a fraction under one-half acre in peaches and about one-half acre in grapes. I used a cover crop until the last five years, then I tried clean cultivation and I am sorry I did so. I find that when a cover crop is used with clean ditches you can hold the moisture better than with clean cultivation. During the dry part of the season in the latter part of July and August, if I loosen my ground in clean cultivation I am unable to get the water through my ditches. (R. 750.)

With a cover crop it was easy to get the water through at all times. With clean cultivation the lower end of the orchard dries up while the upper end is over-watered. I use barnyard manure; no commercial fertilizer. I produced six tons of cherries off the measured part of my land. This is about 50 per cent of a normal crop. (R. 751.)

I raised 2,186 field boxes of apples; this is about 45 per cent of a normal crop. I raised two tons of prunes on the half acre. The trees are old and were old nine years ago, and will not now produce a full crop. (R. 752.)

Last year I had about a 30 per cent peach crop. I raised probably 150 crates. I raised a ton of grapes which is about 2 per cent of normal. The shortness of the crop was not from lack of water in 1933. Everything was watered about right. I irrigate my trees every six days. If I do not there is an inferior quality of fruit. If I miss one watering and go 12 days I will not get the color on the fruit or the size, and if that is repeated once or twice during your season, you had just as well quit altogether and just keep your trees alive. (R. 753.)

Drouth causes a "drouth spot" or brown spot on the prune penetrating into the flesh. In 1933 those spots occurred upon the gravelly part where it is hard to get the water evenly distributed to the ground. None of these spots appeared where the land had sufficient water. In prior years when it was dry, the spot would occur upon the fruit of trees that failed to get enough water, but would not appear where the trees were properly watered. (R. 754.)

In irrigating shallow rooted crops all small garden stuff, and strawberries, we must water every three days or twice during every week. I could not handle my property if I was to garden it or use shallow rooted berries as a good producing farm. I could not cover my property with the water during the last year often enough for that purpose, and last year was a good water year. I covered it once a week last year; but with the same water it would be impossible to cover it twice a week. Last year I covered my one-half acre of garden twice a week; the balance once every six days. My garden stuff was close to the headgate, and when I started irrigating I put it on the garden, and then would go back and do so again. (R. 755.)

A man that makes a success in garden stuff in the gravel fan must irrigate twice a week. Most of them have quit gardening on that account.

I measured the water to the 8 acre tract. I transmitted the measurements direct to Mr. Mason and Mr. Humphrey. They are entered in a book. (R. 756.)

CROSS-EXAMINATION

The first two years I had an acre of strawberries, but I haven't had the grit to try it since. I found I couldn't water my tree fruit and keep up any amount of garden stuff or berries; it didn't allow me to cover my property often enough to keep the moisture near the top of the ground. From one to two feet under the ground we have no soil and must keep our moisture on the surface. (R. 757.)

I get my water from the west branch of the Ford. My ditch to the stream is 50 yards long. The ditch runs through good soil until it gets to my land. Generally I have not enough water to irrigate my land during the summer. I don't know what I am going to do this year. In 1933 I got along the best I have in 29 years. I believe that supply of water was sufficient. The reason they measured my tract and part of my father's together was because these two portions are irrigated from the same ditch. My other water comes from a ditch about 35 rods further up-stream and that was not measured. (R. 758.)

We measured only the one source of supply. The prune trees were old 29 years ago when I took the place. They have been profitable during the time I have had the property. If I could afford to replace them I would replace them. (R. 759.)

The brown spot comes on the fruit, not on the trees, and comes close to the time the fruit is ripening. They thought at first that a pest caused it, but have discarded that idea. (R. 760.)

Testimony of Mr. Piper

(Vol. VI, Transcript, pages 761 to 805.)

I live at Lodi, California, and am a geologist for the United States Geological Survey, specializing in the study of ground water. I graduated from Tufts College, and have two graduate degrees from the University of Idaho. My first work on ground water was in 1921. (R. 761.)

That was in the Goose Creek basin in Southern Idaho. I was with the Idaho Bureau of Mines and Geology seven years, until 1926. From one-half to two-thirds of my work while there was on under-ground water problems. In 1926 I went to the Geological Survey and have been assigned at all times to under-ground water problems. I have worked in Pennsylvania, Tennessee, New Mexico, Oregon, Washington, and California under the Geological Survey. (R. 762.)

I investigated ground water in the Walla Walla River basin. It was a cooperative investigation by the Geological Survey, Oregon Agricultural Experiment Station of Umatilla County, Oregon, and the Washington. Department of Conservation and Development. Ex-16 is the report which I made. It includes a map showing the geological appearance of the valley and the map showing the heights of the ground-water table in the valley during the periods of our investigation. (R. 763.)

First the bed rock which underlies the basin is the base upon which the valley is built. The out-croppings of the bed rock are colored green on the map. They extend along the North closing around the West, except a very narrow gap through which the stream escapes. They extend continuously along the South but are not shown completely on the map; lie slightly to the east. In places the bed rock comes to the surface. That rock is folded in the form of a canoe-shaped basin, the deepest part of which is about south of Touchet. There the dense rock is first reached

below sealevel, and several hundred feet below the land surface. (R. 764.)

From there the bed rock rises in all directions so we have sort of a canoe-shaped depression. In that depression the bed rock is covered with various deposits laid down by streams which make the valley proper. The oldest deposit is shown in the report as the Gardena Terrace on the map indicated by the orange color. This formation is shown by the hills and elevations around the valley. The typical expanse is around Gardena, and from that it is given its name. Near Gardena the terrace is 120 feet above the flood plane of the Walla Walla river. It is the high terrace on which a part of the Gardena tracts are located with remnants in the center and along the flanks. Coming eastward the width decreases until opposite Milton it is perhaps 40 feet. Still further east, northward towards Walla Walla, they are even less than the flood-plain, and east of Walla Walla at the Mill Creek valley they come nearly to the level of the flood-plane. At first that terrace covered the entire basin and was a smooth continuous plain. It has two features or fans with the center about the present canyon of the Walla Walla river at Milton and Freewater, and one with its head near the present village of Tracy. These two fans decline westward, merging in a flat, smooth plain which continued across the rest of the basin. The present remnant is so much dissected that it is difficult to say where they merge, but I believe the original junction would be somewhere in the vicinity of the present course of the Walla Walla river about where Yellowhawk joins. (R. 765.)

Mill creek and the Walla Walla have been the major streams contributing to this. The terrace in its upper part is relatively fine stratified material well exposed near the northern headbox of the siphon on the Burlingame ditch at a wasteway. I refer to the siphon crossing Pine Creek valley. After the formation of the Gardena plain,

the streams cut into it and have formed the trenches through which the various streams now flow. (R. 767.)

At the heads of the two fans, the streams almost completely cut away the top of that old terrace and then began to deposit gravel in the valley which they had previously cut. That process has resulted in two formations, one termed "low terrace" in the report and shown on the map in a brownish-yellow color, which extends but little above the plain nowhere more than 20 feet, and commonly five or 10 feet. They are formed of fine material relatively water-tight. The youngest formation is the coarse gravel forming the fans at the mouth of the canyon of the Walla Walla river and Mill creek which extend outward as tongues or fingers perhaps, one along each of the streams much like the pattern of one's hand, and separated by remnants of the high terrace. The gravel fan raises on and over-rides the deepest of the remnants of the high terrace, or Gardena terrace. The flood-plains which continue on down are built of similar material to the gravel fan, but progressively finer. (R. 768.)

We have records of drilled wells included in the report which give the total thickness of material resting on bed rock. Several are in the western part of the basin. They start on the Gardena terrace, go through that, and penetrate a thickness of gravel; also sand and clay. The deepest of these is between 500 and 600 feet to bed rock. The Milton Nursery Co.'s well (551-B-2) is in Sec. 1, 5 N. R. 35 E. It is south of the railroad crossing and just west of the river. The bed rock was 348 feet below the surface. In Tp. 6 N. R. 33, Sec. 8, the well labelled "Q-1" on the map found the bed rock at 175 feet. The Shields Fruit Co.'s well in Sec. 33 6 N. R. 35, marked "M-1" on the map found bed rock at 413 feet. The Milton Nursery Co.'s well is in 6 N. R. 36 E., Sec. 31, and marked "K-1" on the map is on the Gardena terrace and found bed rock at 417 feet. A well in Sec. 34, Tp. 7 N. R. 33 E., marked "K-1" on the

map is a railroad well near Touchet. The bed rock was 357 feet below the surface. (R. 769, 770.)

In the Milton fan, the widest opening between remnants of the Gardena terrace is near the east, and is now occupied by the little Walla Walla. As you go westward from there across the fan the openings become progressively narrow and less well defined. (R. 771.)

Except for scattered boulders there was no gravel deposited on top of the Gardena terrace at Gardena. It is impossible to tell the young gravel from the gravels which may under-lie the Gardena terrace; together the gravels are several hundred feet deep. In studying the ground-water, I used the methods recognized in the Geological Survey. We selected a number of wells, made periodical measurements to ascertain the static level of the ground-water. From these measurements we traced the fluctuations of that level and have tried to relate these to the source and disposal of ground-water. In determining these the grade or slope of the surface of the country is considered only incidental. The levels referred to are the altitude above sea level, and we deal with the form of the water table, not of the ground surface. The land surface from Milton and Freewater north, slopes about 80 feet to the mile; it is steeper close to Milton, and becoming flatter as you go outward to the north and west. A relatively steep grade continues up-river above Milton. (R. 772.)

We tried to select wells representative of the natural range and conditions, and to include both deep and shallow wells in our observations. The observation wells cover the entire district north to Mill creek, and are shown on plate 5, of Exhibit 16. Plate 5 shows the water table at two periods, one on June 20, 1933, the other August 29, 1933. The first period is when the wells within a few miles of Milton stood at their highest points for the season as we observed them. On August 29th they were about at their lowest period; after the peak of June. (R. 774.)

The contour lines are drawn upon the table and the marking "750", etc. is the feet above sea level. There is 50 feet between contour levels. The solid line shows the June 20th period, the dash line shows the August period. The differences in the water table are shown by lines so drawn as to divide the areas in which the water has fallen or risen an equal amount. (R. 775.)

The line crossing the Tum-A-Lum near the southwest corner of Sec. 24, 6 N. 35 E. and running nearly due west separates an uncolored area to the north from the area shaded pink. The differences between the solid contour lines and the dash contour line shows the amount which the contour has moved because of the fall of the ground-water table. The ground-water level is on a grade, similar to a hill of water, and as the table declines the contour line would move apparently up hill. (R. 776.)

Colors are used on the plate to show areas of equal rise and fall. Where the map is not colored, the table fell less than 5 feet during the period. In areas shaded, the lightest tone of pink the water fell more than 5 feet, but less than 10 feet. The next greater density of shading indicates a fall of more than 10 feet, but less than 15 feet; those small areas of the greatest density is where the table declined more than 25 feet. The greatest decline was 28 feet and a fraction. There is no area of more than 30 feet decline. The blue shading shows where the water table rose. The triangular area crossing the state line and across which the east fork of the Walla Walla passes; the small area above the head of Yellowhawk creek and a small area toward the head of the gravel fan near Freewater. In none of these does the water rise as much as 5 feet. (R. 777.)

Where the contour lines are far apart the grade is relatively gentle; when they are close together the grade is steep. The water in the gravel would move or percolate exactly as though it were surface water flowing down hill; in other words, it moves directly down the slope; therefore

it moves at right angles to the contour lines. If the gravel is of even texture, the rate of movement is proportionate to the grade, or inversely proportional to the spacing between contours. (R. 778.)

June 20th the contours of the Milton fan were roughly circular, about an apex in the vicinity of Milton. (R. 779.)

The water was highest in the Tum-A-Lum fork in that district. The water level in wells adjacent to the river would very nearly meet the water surface of the river; and the observation wells near the river rose and fell in a pattern similar to the rise and fall of the stream, and we conclude the ground water rises and falls as the river rises and falls. Their form is roughly conical. The water becoming ground-water high in the fan, could percolate radially outward down that slope over practically the entire width of the fan in a rudely conical form, could pass along the western-most edge of the fan, to the northwest, or nearly northward. (R. 780.)

The slope would be almost symmetrical, both to the west and east sides. (R. 781.)

At a point on the Tum-A-Lum to the north line of Section 36, Tp. 6 N. R. 35, about halfway between the Nursery bridge and the McCoy bridge, between the 900 and 950 foot contour levels, the water leaving the river would be bound by a radii drawn through that point down the two slopes. It would be limited on the west, by the line drawn from the N. W. corner of the fractional S. W. ¼ of the NW¼ of Sec. 14, on the state line to the point designated as the point where the seepage would start. This line would limit on the west the area within which there would be free percolation and roughly includes the drainage basin of the East Little Walla Walla, and extends nearly to the west frog of the Little Walla Walla. (R. 782.)

Water leaving at a point near the Nursery bridge would be limited in similar fashion by a radius drawn at right angles to the contour, intersecting the state line nearly at

the west boundary of Section 15, Tp. 6, R. 35. The radius is along the west fork of the Little Walla Walla. Seepage from the points mentioned does not go south, any more than water would run up hill on the surface; the pressure from the south would prevent that. We based our maps on observations of 115 wells, and I believe that to be a representative number of wells. The form of the table cannot be determined in its ultimate detail but that number of wells should define its form with all adequate refinement. (R. 783.)

The largest number of wells from which pumping is carried on are confined mostly to Sections 25 to 27 inclusive, and Sections 33 to 36, or perhaps 35 inclusive, Tp. 6, N. R. 35, as shown on Exhibit 17. (R. 784.)

The greatest fluctuations of the water table we have observed is in that district, but I wish to make clear that there is not a depression in the sense that there is a cup-shaped hole in the table. There is a continuous northward slope across it. The table rises 50 feet between the two contours. If it declines only half of that amount it is not sufficient to put a depression in it there. It is a steepening of the grade to the south, then a flattening, but nevertheless a continuous northward slope; and beyond that district a steepening again. There is no reservoiring of the water there, and the gradient is not reversed so that water is not drawn back from the north. Its normal direction of motion is not reversed. (R. 785.)

The contour upon August 29th shows a change of grade, but no departure of the general conical shape that persisted before the decline. The grade at that time is considerably flatter between the 900 and 850 foot contour; although the grade is flatter, there is a continuous downward slope across the district so that ground water still moves across it. (R. 786.)

I do not feel justified in a conclusion that the variation of the ground water table at the points where it showed

more than 25 feet decline was caused by pumping, speaking particularly about the highest part of the fan near Milton and Freewater, and extending northward and westward to the 800-foot contour line on plate 5, Exhibit 16. Several of our wells fluctuated as much as 28 feet between June 20th and August 29th. If that were caused entirely or largely by pumping the recovery would wipe out that decline after the pumping stopped, but it does not. Another thing to consider is that at that time of the year those wells do not stand at their lowest. We selected wells in the winter of 1932, in December, and installed float gauges. (R. 787.)

From these we ascertained that the lowest point of the table is not late in August, or late in the period of pumping, but in February and March, a period when there was but little irrigation and no pumping. From that low point in February and March they begun to raise and they lost as the freshet came down the river and reached their highest point not long after the freshet was at its highest point. There is some lag; not much. They declined as the freshet declines and began to drop before pumping started. This is illustrated by the Hayden well, Sec. 25, Tp. 6 N. R. 35 E. on the map "P-1". In that well the table rose as the freshet came down the river, and began to decline immediately the freshet had passed, and after the channel opposite the well was dry it began to fall rapidly and declined a number of feet before any pumping started in the vicinity. (R. 788.)

My information is that the well had fallen 15 feet before pumping started. The same is true in other wells. This is typical of several near the river. I would consider the ground water supply a wave. In some wells the table rises in response to the river, and the spreading of water over crop land near the wells causes a rise; rainfall also does. The water table falls as pumping becomes general and as the river declines. (R. 789.)

The effect of evaporation and heat would be slight; more than one of the agencies causing the table to fluctuate

are active at the same time. Irrigation begins while there is water in the river. At the same time the river was rising and wells were rising with the river, water was spread for irrigation and it is impossible to say what fraction of the total rise is due to the river and what to irrigation. The same is true of the fall. The pumps are turned on as the river declines, the depression of the table, due to pumping begins soon after the water table begins to decline, because the freshet had passed, and as the peak of the wave of the water table had passed, and our data does not justify an estimate of the total fluctuation due to the several causes because they are working concurrently. (R. 790.)

The depressions, or flattening of the water table from pumping, causes the water table to steepen to the south so that it moves northward more rapidly. It does not destroy the general form of the table. (R. 791.)

A slightly greater portion of the total movement would be in the eastern half of the fan; a slightly greater portion. It would tend to cause more flow to the north than to the west—relatively. The model was marked "Oregon-38". (R. 792.)

The model is the same as plate 5, except it is in relief, while the other is plane. Along the higher part of the fan the percolation of the ground water is constricted by the remnants of the Gardena terrace, but in passing outward the alluvial gravel separates two fingers, which passes between the fingers of the Gardena terrace. The gravel is highly permeable but is breaking into tongues separated by relatively impermeable material. The effect is to reduce greatly the area of cross-section in the gravel through which the ground water can move. (R. 793.)

This occurs about 3 miles north and west from Milton. Along the eastern tips of the remnants of the Gardena terrace there are about four miles of width in gravel through which the ground water can percolate, and a mile further out that width is reduced to perhaps one-half of

that. The greatest constriction is toward the west. Those are the least distinct and narrowest of the channels, and have the least of the gravel. At Milton and Freewater the contour shows a general dispersion away from the stream. At the 800 foot contour and lower contours they trend west of north; to the north of the Walla Walla river, but as they cross the river they swerve toward the west and southwest, so that on plate 5 they have a general "V" shape with the point of the "V" beneath the river. The water converges toward the river both from the north and from the south. The contours indicate from the 950 contour to the 800 foot contour a losing stream. (R. 794, 795.)

From the 800 foot contour for a distance it indicates a gaining stream because the table slopes to the stream from both sides. The springs are segregated into three groups; the inner zone contains most of them and is between the 800 foot and the 850 foot contours as shown on plate 5. They are arranged in a zone from half a mile to a mile wide and roughly circular. Beyond that there are fewer springs arranged in an intermediate zone between the 700 and the 750 foot contours, and in the outer zone, between the 600 and 650 foot contour. By far the most of the springs are in the higher, inner zone. That indicates that the surface grade is such as to overtake the water grade, or water table surface. (R. 796.)

My conclusion is that the constrictions caused by the Gardena remnants have been so great that the ground water is not free to percolate beyond that constriction as it was to the south of it, and therefore the constriction acts as a partial dam, forcing some water to the surface so that it breaks out and forms the springs. The McCoy bridge is at the southern edge of the inner zone. (R. 797.)

It is not possible from the data available to show that the form of the water table in any major feature is the result of irrigation or the result of pumping. It is my judgment that the general pattern of the ground water circulation is natural, modified partly—but not to a major extent

—by irrigation and pumping, and we cannot conclude that the pumping distributes the water further to the west. I have received data subsequent to my report (Ex. 15) and down to the present time, but that data does not change the conclusions set forth in my report. I have found nothing in it to modify the major conclusions represented in the report. (R. 798.)

CROSS-EXAMINATION

The water table is a simple water table condition. The source of supply is the drainage area of the Walla Walla valley. The springs in the area formed three miles north of Freewater to the state line are supplied by ground water. That includes the seepage in the lower Tum-A-Lum. (R. 799.)

There are no static waters in the table. The springs are produced by an intersection of the water table and the surface, and are not the overflow of an underground reservoir. The tapping of the underground stream by wells would be the tapping of a moving supply of water. (R. 800.)

Most of the irrigation wells tap moving waters. (R. 801.)

RE-DIRECT EXAMINATION

Exhibit 16, figure 4, following page 67, is a profile showing the surface grade and the ground water table. (R. 801.)

It shows the slope of the ground surface, also the slope of the water table at different periods. (R. 802.)

The diagram shows the slope of the table at four periods, going back to August 22, 1932. In December from the 1st to 5th, 1932; in April from the 4th to the 6th, 1933, and June 20, 1933, so as to show the lowest position of the table, and in several steps up to its highest position, which was June 20, 1933. The dash line upon a cross section would be a fair representation of how the depression affects the water table. (R. 803.)

Arthur M. Piper

(Transcript pages 835 to 836.)

I am experienced in measuring and estimating the energy input to an electric pumping plant. Where extreme accuracy is necessary the input is measured by tapping special instruments into the line leading into the motor. Ordinarily we determine the energy input by timing with a stop watch the rate at which the disk in the meter rotates; determining the number of revolutions per second. From the manufacturer we have constants for the types that need it, that give the rate of energy input for each revolution of the meterdisk, and from that we compute the rate at the time of observation. That method is quite as accurate as the measurement of the quantity of water. More refinement is not justified or necessary. In recent years I recall two tests that were in error; the meter was not in proper working order. In one, two coils of the meter had burned out and in the other the meter had been tampered with. The effect of both of them was to indicate one-half of the quantity put in. Ordinarily if any thing is wrong with the meter it throws it out so far that it is obvious something is wrong, and the person observing it would discover the error. (R. 835.)

Testimony of C. J. Karker

(Transcript pages 805 to 811.)

I live on the highway one and one-half miles north of Freewater and three miles south of the state line, and farm 6½ acres. This was one of the test places in 1933, and under this test 5 9/10 acres were included. The soil is gravelly and rocky. (R. 805.)

I have cherries, apples, pears, peaches, and prunes. One-half acre of cherries; 3½ acres of apples; ¾ acre of prunes, and about a quarter of an acre combined in pears and peaches. This place has had an alfalfa cover crop, but is now ready to change to clean cultivation. (R. 806.)

I used no fertilizer during the test. I raised one and a quarter tons of cherries, but the tract included some young trees. On the larger trees that would be an 80% of normal crop. I raised 2300 field boxes of apples; this is about 85% of a normal crop. (R. 807.)

I raised four tons of prunes which was a normal crop. I had no peaches on account of the season, but I had a normal crop of pears. I measured the water to the land in accordance with instructions given by Mr. Mason and Mr. Humphrey. I measured it correctly and entered the measurements in a book and turned the book over to Mason and Humphrey. It takes a week to irrigate my place. (R. 808.)

I rotate with no one and when I complete one irrigation I immediately start again so that my land is irrigated once each week. If I miss an irrigation it shows in the quality and quantity of the fruit. 1933 was the best water year for several years, but I did not have too much water. I raise Delicious, Winesaps, and Rome Beauty apples. (R. 809.)

A dry year has the effect upon Winesap apples of making a depression in them that turns black and makes the apple a cull. This spot appears along toward the maturity of the apple but does not appear when the apples have plenty of irrigation. I have raised apples for 20 years on this place. My water comes from the East Branch of the Ford. (R. 810.)

CROSS-EXAMINATION

My water may come from the West branch of the West branch of the Crockett. The stream goes through my place and my ditches take out on my place. (R. 811.)

D. H. Babcock

(Transcript pages 812 to 821.)

I live one mile west of the highway and one-half mile south of the state line in Oregon. I farm by irrigation and could not farm there without irrigation. My place was one

of the test places in 1933. I made measurements of the water used under instructions from Mr. Mason and Mr. Stricklin. (R. 812.)

I followed the method they gave me, recorded the measurements in a book which I turned over to Mr. Mason. I had 10 acres under the test all taking out from one head-gate. (R. 813.)

I raised apples, prunes and cherries. I had four acres of prunes, which produced 14½ tons, and was about 50% of a normal crop. I produced 700 field boxes of apples, which ran 50% fancy and extra fancy, the balance being "C" grade and culls. Part of the "C" grade and culls went to the dryer. The apple crop was about 35% of normal. I had an acre of cherries which produced 500 pounds. (R. 814.)

This was ¼ of a normal crop. I think that the frost caused this shortage. I had a garden for my home use. In 1933 the water supply was sufficient and the shortage of crops cannot be attributed to lack of water. In 1933 we had a great deal more water than usuanl. Our water supply depends upon whether or not it is a wet or dry year. (R. 815.)

In 1933 we had as much or more water than we generally have. I spring-tooth my place thoroughly and then let alfalfa and weeds grow up and cover the ground. I use barnyard fertilizer on part of the tract, but use no clean cultivation, and never have, although I have watched the results of other people's experiment. In my opinion the cover crop best conserves the moisture in that territory. My runs are 20 rods long, and I try to get over my place in three days and 18 hours. I rotate. (R. 816.)

The schedule allows me three days and 18 hours use of the water, and during that time I get water for approximately 20 acres. I rotate with E. J. Chastain and Mr. Watson. Chastain has 20 acres and Watson has 10. Under

the schedule I get one-half of the total flow part of the time. (R. 817.)

In keeping measurements, I measured only water that went on my place, and went over my weir. Part of the time I am unable to get over my place in 3 days and 18 hours. If I am unable to do so, the shortage of water affects my fruit. It wilts some of it, and some of it falls, especially the prunes, and reduces my yield. (R. 818.)

It also reduces the grade of fruit. This I know from my own experience. My house garden is a short rooted crop, and in my 3 day and 18 hour period I irrigate that twice, but my deep rooted crops just once. There is no surface waste or waste that I can see from my place. (R. 819.)

CROSS-EXAMINATION

I get my water from the west prong of the Little Walla Walla.

I think that 2 acres of my land has a later priority than the balance but cannot say. My land is one-half mile from where my ditch takes out of the west prong. Chastain is above me on the ditch and Watson below me. When Watson and I use the water we use Chastain's water also. Chastain has another ditch. I have a weekly rotation. (R. 820.)

Charles Eiffert

(Transcript pages 822-834)

I live on the Oregon side of the state line about a quarter of a mile west of Milton highway, and farm by irrigation, and could not farm without irrigation. I have lived in the vicinity for thirty years, and have owned this place for 16 or 17 years. (R. 822.)

My water comes from the east prong of the Little Walla Walla. My soil is underlaid with gravel. There are 4 acres covered with silt; the rest has rocks and gravel on the top. On the 4 acres the soil varies from small out-croppings of rock to 5 feet in depth. This place was one of the test places

in 1933. Clarence Zacharias — my employe — made the water measurements. (R. 823.)

He made them under the supervision of Mr. Mason and Mr. Humphrey, and I, myself, checked the measurements. I knew the instructions he got and when I watched him he followed those instructions and entered the results correctly in the book furnished for that purpose. I raised approximately 7 acres of prunes; 5 acres of apples; about 2 acres of melons, and one acre of potatoes, and a little more than 1 acre of squash, and raised hay between my rows of trees. (R. 824.)

There are 16 7/10 acres in the measured tract. My prunes were about 65 tons, which is about 85 per cent of normal. It was an off-year for apples and I didn't get anything except on the Rome Beauties; they produced about 500 boxes. I have Winesaps and Delicious trees also. The early apples more or less just bear one year and then rest a year, and in 1933 they were resting. The Rome Beauties bear more or less every year. (R. 825.)

Of the 500 boxes I would consider it from 15 to 20 per cent of a normal crop. My squash produced ten tons which was a good yield. The melons were muskmelons and cantaloupe, and produced around 300 crates, which was practically normal. (R. 826.)

I got 120 sacks of potatoes, which was a short yield because I dug and sold them for early potatoes. One cantaloupe patch was on gravelly rocky land, which brought my yield down some. The squash, muskmelons, and potatoes were on the side where there is silt and dirt. I had no cover crop except that when it became impossible to cultivate, the weeds grew up. I cover one-half of my place each year with barn-yard manure and have for the last several years. In 1933 we had a good water year. (R. 827.)

It was away above the average and the shortage of crops was not due to lack of water, except my cantaloupe patch was not properly watered once. I get over my place in 8

days, or about one week, and rotate with nobody else. My place is 70 rods long and is divided into three divisions so that I have three runs in that length. In the better class of soil my runs are 35 rods long. There was no surface waste from my place. (R. 828.)

I had no drouth spots on prunes in 1933, but in former years when the water has been short there was a black spot that they call a drouth spot. (R. 829.)

It causes the prunes to be culls, but never appears when there is plenty of water. Last year I didn't run my pump at all, but for about a week we had to do extra work and crowd the thing to get by and I ran the pump a short time. I use my well to supplement the supply from the river when that supply gets short. Ordinarily I use the pump for a short while. Last year is the only year I got by without it. (R. 830.)

CROSS-EXAMINATION

I have used the well every year since I put it in, which was around 1918. The well is 162 feet deep. I deepened it about three or four years ago. It is a dug well for 20 feet and the balance is drilled. Three or four years ago the well was about 50 feet deep, and I drilled it to 165 feet, but it did no good. (R. 831.)

When there is a cool or cloudy stretch of weather the water raises in the well, and when it is hot and dry it lowers the water and changes. A few days cooler weather makes a difference. From June to July the water is highest in my well. It is then from 12 to 14 feet from the surface of the land. The well will not hold a three inch pump and will pump it dry. (R. 832.)

It is about a normal three inch pump, but is belt driven and will not pump as much as though it were electric driven. I do not use it enough to pay me to use electric power. My water comes from the Ingles ditch. It is about 150 rods from where that ditch takes out of the stream to my place. (R. 833.)

Mr. Bookout

(Transcript 837 to 841)

My name is Lloyd Bookout. I live near Pleasant View school, 3 miles south of the state line and 2¾ miles west of the Milton-Walla Walla highway. My soil is sandy. I had a plot there that was one of the test places. The water was measured to it under instructions from Mr. Humphrey and Mr. Mason. (R. 837.)

I irrigated around 15 acres from that measured water. I grew oat hay and alfalfa. I used no fertilizer. We fed the hay, but there was approximately 37½ tons. The measurements were made as directed, and recorded in a book and transmitted to Mr. Mason and Mr. Humphrey. They were correctly taken and correctly entered. The amount of water supply was quite a bit better than in former years. (R. 838.)

Although the water was better than it had been for years, we could not irrigate all of the land. Part of the place was new alfalfa, with oats for a cover crop. The balance was old alfalfa. The hay crop was fair. It takes about a week to go over the place. We irrigated every week or ten days. We get our water from the Pleasant View ditch and did not use our well. Our diversion point from the ditch is on our place, but it is about 3½ miles from where the ditch diverts. (R. 839.)

Clifford B. Harris

(Transcript pages 841 to 845)

I live one mile south of the state line and a mile west of the highway. I irrigate 9.53 acres. My land and my neighbor's to the south make 13 acres. He is my brother-in-law. (R. 841.)

We measured the water to the land as instructed, made the entries in a book, and reported them correctly. 9/10 of the place is silt without rock, the rest is rocky. On this 13 acres we raised prunes, corn and garden truck. There are 6 acres of prunes on my place, and 4 on my brother-in-law's.

I raised an acre of corn in among young apple trees. I had 47 tons of prunes, and my brother-in-law had 30 tons. The crop was slightly under normal, about 85 per cent. The corn produced from 60 to 75 bushels to the acre last year; this is about 50 per cent crop. During the dry season we rotate between the two places, but normally we do not. The water for the 13 acres is used by both of us at the same time. It takes a month to cover the place. (R. 843.)

Once a month I irrigate each part of my land. (R. 844.)

CROSS-EXAMINATION

My water comes from the west prong, and my take-out is about 400 feet from my land.

RE-DIRECT EXAMINATION

My land varies in depth from two to four feet with some spots where rocks come to the surface. Underneath the soil is a mixture of gravel and sand with very little soil in it.

I water my prunes once a month. My soil does not take water as fast as the rocky soil. It retains the moisture better than the rocky soil. (R. 845.)

W. H. P. Herman

(Transcript pages 846 to 851)

I live two miles northwest of Freewater and three miles south of the state line. A mile east of the state highway and on the east side of the river. I irrigate through the East-side ditch, and have 30 acres, but on the test place there was only 19½ acres. (R. 846.)

I made the measurements under the instructions of Mr. Humphrey and Mr. Mason and recorded and reported them correctly. I raise cherries, apples, prunes, peaches, grapes, and garden. There are about 120 cherry trees that are just bearing. This year we will have a fair crop, but up to now they have been too young to amount to much. We have 120 bearing apple trees and over 100 young trees. (R. 847.)

My prunes are scattered about over the place with apples in between. A fair estimate would be about 13 acres.

I have no peaches except a tree or two for our home use. Last year there was but a few hundred pounds of cherries; the weather interfered with them to some extent and it was a young tree crop. I took off 67 tons of prunes, which is about 80 per cent of normal. I got 200 boxes of apples from 120 trees, which is about 15 to 20 per cent of a crop. (R. 848.)

The shortage was not due to lack of water. It was an off year for the trees. I use a cover crop; alfalfa in some of the apples, and just weeds and grass in the prunes. The last year or two I have used no fertilizer. My runs vary from 15 to 40 rods. I get over the place in less than a week, and immediately start right over again. Last year some of the prunes dropped because of not getting back in time. With shallow rooted crops you must get over them twice as often as fruit trees. (R. 849.)

In the summer when it gets dry I do not raise short-rooted crops. I don't plan to have anything in my garden that requires water through the summer because the water supply would not take care of it. I plant my place to crops that the water supply will handle. If any further cut was made in the water supply I would have to let some of my orchard go. I could not grow anything without irrigation. (R. 850.)

CROSS-EXAMINATION

(Transcript page 851)

The East-side ditch is on my property line. (R. 851.)

Mr. Humphrey

(Transcript pages 862-884)

I live at Salem. I am assistant to the state engineer of Oregon and have been since 1922. My work is hydrographing, map work, duty of water work, and use of water investigations, and has covered various stream systems in the state of Oregon. In several adjudications I gathered the hydrographic data for the adjudication. (R. 862.)

I was in charge for Oregon of gathering the data in this case. I also prepared maps and did plane-table-work in the various adjudications. I made the plane-table-survey of the irrigated areas on the Gardena ditch. (R. 863.)

This was made in the fall of 1933. Oregon Exhibit "40" is the map I prepared and correctly shows the irrigated area in 1933. The figures in each 40 acre sub-division show the area irrigated in that 40. Cross-hatching in one direction indicates land irrigated in 1933; the cross-hatching in the opposite direction shows lands which had apparently previously been irrigated. (R. 864.)

These were not irrigated in 1933. There was a total of 5,251.25 acres irrigated in 1933. (R. 865.)

I prepared the graphs which are Oregon Exhibit "41". The graphs are based upon the information in the data book. (R. 866.)

My studies reveal that there is a direct relation between the rise and fall of Mill creek and the Walla Walla river. (R. 867.)

(Exhibit "41" was not offered because it included estimates.) The records of 1914, 1915, and 1916 of Mill creek and the South fork show a distinct and evident relation between the flow of the two streams. (R. 868.)

Exhibit No. "42" covers the use of water from wells. The studies upon which this exhibit is based extended through June, July, August and September. (R. 869.)

Describes the table covering the test places. In selecting test places we tried to select ranches farmed by good farmers with their delivery system in good condition. Not the very best, but in general good, and distributed over the area so as to have a fair representation of the use of water in that district. 1933 was a year of plentiful water supply, the best for a number of years, owing to the way the water came out of the mountains it was available at the proper time. (R. 871, 873.)

We tried to give these test places what we considered a proper supply of water for the irrigation of that partic-

ular land. The fifth page of the exhibit shows the delivery of water to Gardena in 1933. (R. 874.)

It is based on the record in the base date exhibit "18" and the compilation of the application of water to the acreage is based on the number of acres my survey showed. I allowed 12.7 per cent for canal loss. This allowance is based upon several measurements made by myself on the canal in 1932, and considering the character of the canal it probably would not change greatly so that the transportation loss would be about the same for 1933. (R. 875.)

The volumes of water in the canal were about the same in 1932 and 1933. The estimate of miner inch application per acre is based on the Oregon miner's inch, or 1/40 of a second foot. As to the use of water from the wells, we selected a number that were considered representative and had representative equipment, which we tested for efficiency, and then referred to the power bill paid by the owner to get the approximate amount of water pumped from the well. Next to the last column shows the power bill for the year. (R. 876.)

The tests for efficiency of the pumping equipment were not all made on one date, and most of these tests were made by Mr. Robinson and Mr. Mason. Robinson worked in there with Mr. Piper. On page 79 I worked up the material, most of which is in Mr. Pipers report. (R. 878.)

The total amount of money expended for power for pumping for irrigation to the Pacific Power and Light Company for 1932 was $11,789.32; to the Milton City Power Company for 1931 it was $3,710.47. There would not be much difference between the years 1931 and 1932. These two places were the only sources of power for operation of wells by electric energy. (R. 880.)

The figures include only the power consumption; no house consumption for lights or house-hold appliances are included. (R. 881.)

CROSS-EXAMINATION

I am not acquainted with the rates charged by the Pacific Power and Light Company. The bookkeeper gave me these figures. The amount of water used is for the time covered. (R. 881.)

(There was some cross-examination as to the tables, but Mr. Cunningham said that he had misunderstood the tabulation and asked for more time.) (R. 882.)

CROSS-EXAMINATION (By Tim Paul)

Q. It is probably true that land between plantings with alfalfa, wheat or barley would not show indications it was irrigated? (R. 883.)

But I will make that plainer Mr. Paul. Before I made that survey I asked Hartvedt if he would recommend some man he thought would be competent to help me, and who would be familiar with the project and he recommended Charles C. Hanning who had lived on the project a number of years and worked on the delivery system for several seasons and was quite familiar with the project and was of considerable help in making determinations you spoke of. In cases where visible evidence as to the status of the land was lacking, I took Mr. Hanning's statement as to whether it had to his knowledge been irrigated or not. If it had, I put it down as having been irrigated, even though it might have looked as though it had never had water on it. (R. 884.)

CROSS-EXAMINATION—886-894

Exhibit "42" with the exception of the pages entitled: "1932 Use of Water From Wells and Pumping Equipment Efficiency Data", refers to the test places. With the further exception of the tables showing the principal delivery to Gardena. The column headed: "Soil Class" on page one, was taken from the classification set out in Young's map, Washington's Exhibit 15. In measuring the water to the test places we measured the head on the weir. The land owner used a rule or scale. (R. 888.)

I was there twice during the season, myself, to instruct the land owner, and in the remainder of the season the measurements were taken by the land owner under the supervision of Mr. Mason. I could not say the average of errors there might be, because the errors might be in either direction. I would say it would not exceed 2 or 3 per cent. With small heads there is a possibility of greater error. I believe the 2 or 3 per cent margin is very low. (R. 890.)

The acreage was determined by reference to the adjudication map, and in case of doubt I chained the tract. The correct acreage would be the acreage as shown in the table. I have no way of knowing that the land owner used the water on the limited acreage set out in my table. (R. 891.)

Referring to the tabulation, the test places may be found in the Oregon Decree as follows:

Charles Eiffert 116
Knopf (John Gunn) 130
Herman (place) 138
Herr (place) 139
Karker (place) ..... 149, and 109 under the name of "Corkery". The Babcock and Harris places take water from the west prong, and the Bookout from Pleasant View. (R. 892.)

RE-DIRECT—893

Ed. K. Humphrey—Re-direct
(1157-1170)

I received the acreage figures compiled by Spencer, Perry and Mason and compared them with tabulation No. 4 —Washington's Exhibit 30. Referring to Oregon's Exhibit—44, the first column "Acres" are the acreages turned over to me by the men I mention, as a result of their compilations and check. The first column is the names of the ditches. These correspond with the lower one-half of Doctor Woodburn's tabulation No. 4. (R. 1157, 1158.)

The second column, or the one to the right of that, headed acres, is the amount of "water decreed at the user's weir," which is the point of diversion from the channel. On the Milton ditch and the Perkins ditch there is a special duty provided by the decree for the small acreages of one and a half miner's inch of water for a tract of land over one-half acre and not over a full acre, and a full inch of water where the entire tract is under one-half acre. (R. 1159.)

In my tabulation I included that special allowance. The next compilation of 20 per cent transportation loss listed for the West Crockett, the East Crockett, the Ford, and the East Side ditches is the transportation loss for a natural channel.

The column headed "Total Necessary at Measuring Point to Deliver Decreed Amount," includes the transportation loss and the decreed amount. All quantities in the tabulation are expressed in second feet.

The column headed "July Mean Diversion," is the mean diversion that Dr. Woodburn used. The two columns—one headed "Under-Diversion," and the other "Over-Diversion," is the difference between the amount necessary to deliver the right and the mean diversion. The same thing is true for the heading under the month of "August". (R. 1160.)

I made those computations myself, and as a result of the computation in the month of July there is an over-diversion of .81 second feet only. In August there is a net under-diversion of 4.5 second feet. If there is an excess of water in the Milton ditch so that it runs out at the tail of the ditch, that irrigates the Finis ditch lands, approximately 107.5 acres, and that is the note I have placed on the bottom of the compilation. (R. 1161.)

I have worked for the state engineer's office on several different projects. I was investigating use of water and methods of use upon those places. Upon this particular project, in investigating for the original adjudication, I was working while irrigation was on, and during the time

water was short. I was mapping and going over the territory, including the irrigated district on the gravel fan, and pretty much all over the area. I had a chance to see and observe the methods and use of water practiced by the farmers. (R. 1163.)

At that time I saw no evidence of waste in the use of water. In connection with my investigation and study for this case. I had occasion to investigate diversion works and measuring devices. I have personally gone over the system. I believe that the diversion works and measuring devices here are a little better on the average than those in other districts where conditions are at all similar. During all of the time I have worked in there I have seen no evidence of any substantial waste. There have been instances of slight waste, but very, very slight. I made investigations as to duty of water on the Oregon side of the line, and particularly upon the gravel land. Where the inch and a half duty was allowed upon the gravel land I saw no evidence that they were getting too much water. I did not make a detailed study of the deliveries upon the spring branches, the East Prong, Big Spring, and Lewis Spring branches, but from observation and comparison, and my observation of the records I do not believe they are getting one and a half inches on these branches or that they were when I was through there. My conclusion as a result of my studies is that the required duty of water upon the gravel land is an inch and a half per acre. As to the lands upon the spring branches the East and West prongs below the gravel fan, those are different textured soils down there and from my experience should have probably from an inch to almost an inch and a half.

I have gone over Young's soil map in evidence as Washington's exhibit No. 15. (R. 1164, 1165.)

I have attempted to ascertain the areas of the different classes of soils. I have examined it to ascertain whether I could take that soil map and the Oregon decrees and from them determine the particular kinds or quantity of the

particular kinds of soil upon the holdings of the various individuals, and I believe it would be an impossibility. (R. 1166.)

HUMPHREY—CROSS-EXAMINATION

In speaking of the duty of water from surface indications I came to the conclusion that they were using all of the water they were diverting, and there was no apparent waste. On Oregon Exhibit—44 under the word "channel" the names cover partly streams and partly ditches; the Stillman, the Milton, the Powell, the Perkins, and the Tum-A-Lum are ditches. (R. 1166.)

I can't say how much of the East Side ditch is part of a natural channel. It is a natural channel that has been straightened and improved. If it has been extended I can't say to what extent. It is near the main stream. For practical purposes it cannot be considered a ditch. It is a stream that has in the past been known as "Little Stream" and is a natural channel. I believe that would make a difference in the measuring points. Any diversion out of "Little Stream" are diversions out of the natural stream, and the decreed amount of water should be delivered at that point to the user. We do not apply the same rule to ditches.

The West Crockett, the East Crockett, the Ford, the East Side ditch, the McCoy stock ditch—which is an addition to the East Side ditch—are all natural streams and the measuring points on them are the points of diversion for each individual landowner. (R. 1167.)

The others are constructed ditches and their measuring point is at the most convenient location near the diversion point. (R. 1168.)

HUMPHREY—RE-DIRECT

The Tum-A-Lum as referred to in Exhibit means the Tum-A-Lum ditch and not the Tum-A-Lum river. The Tum-A-Lum ditch is a small ditch which takes out of the Tum-A-Lum river near the East Side diversion and on the opposite side of the river a short distance above the East Side. (R. 1169.)

HUMPHREY—ANSWERING QUESTIONS FROM THE MASTER—1169

I am familiar with the lands colored orange on Exhibit 15 upon the fan of Mill creek. They do not compare at all as to occupation and cultivation with the fan at the mouth of the Walla Walla. There is quite a percentage of them not cultivated or occupied at all, as compared with the intense cultivation and orchards on the gravel fan of the Walla Walla. The occupancy is entirely different. I am not so familiar with the lands colored orange to the west on Exhibit 15. I can't say exactly as to them, but they are more nearly comparable to the gravel fan on the Walla Walla than the gravel lands up Mill Creek. (R. 1169.)

FURTHER QUESTIONING BY MR. RANDALL

The second orange belt referred to is largely within the city of Walla Walla; it is difficult to tell from this map; the boundaries of the city are not marked definitely, but I would say that most of that lies within the city of Walla Walla. (R. 1170.)

Powers—Direct Examination

(Transcript pages 1002 to 1036)

My name is Wilbur L. Powers. I reside at Corvallis, Oregon, and have for 25 years. I am soil scientist and have charge of the soil department at the State College of Oregon at both the college and the station. I have had 27 years experience with soil, soil classification, and water requirement work for irrigation practice and experimental work. I am a B. S. and an M. S. in agriculture. (R. 1002.)

Most of my undergraduate work was at the University of Illinois, but the degrees were from the New Mexico Agricultural College. With reference to soil matters I have traveled in ten foreign countries, a good part of the time in Russia and in the Northern European countries. I have supervised for the state the cooperative detailed soil survey

work for 15 years. I have carried on investigations as to water requirements in many places in the state. Irrigation and drainage investigation has been included in the soil work all these years. (R. 1003.)

I have classified land a great deal for the Federal Reclamation Bureau and have classified several projects in Washington. I worked with Johnston on the Sunnyside division of the Yakima project and wrote a reviewer's report. The Reclamation Bureau called me in for that work. I have been employed by the Reclamation Bureau as consulting irrigation economist and consulting reclamation economist in a number of their projects. I have examined soils in and around Milton and Freewater and the Walla Walla valley generally. The soil in the basin is derived from basaltic material; some recent, some fairly mature, largely water-laid, but wind-laid in part, and where more mature the profile development is the result of climate and the vegetation it brings in. (R. 1004.)

There is a zoning from the gray desert soils at the lower end of the project, then a zone of light brown semi-arid soils including the loess of the benches, then a zone of brown soil and black earth, and finally leached coniferous soil near the forest. Interspersed with that there are areas of meadow soil affected by waters and areas that have become alkaline. The organic matter in the native state is related to the amount of moisture supply, and salt distribution is related to the drainage. There is more of a leaching out in the upper coarser areas and accumulations so as is general there is more alkali as you go down stream. My first visit to this area was about 1914, and I have been in here at times since then to study the irrigation situation, but more intensively during the last year or two. (R. 1005.)

As to the soil map, when the request came for the map we were engaged in a detailed soils survey in cooperation with the U. S. Bureau of Chemistry and Soils, and I requested of the chief, Dr. Marbut, permission to use the

field sheets as a base for a soil map. The soil survey we were then engaged in was in Umatilla County, including the Milton and Freewater districts. We photographed up the soil map as far as it was finished, which was only from about Freewater to the State line, and from the bluffs east of the river, west to Umapine. In photographing up the paper shrinks a little, and any errors are magnified a bit in photographing it up to approximately a two-inch scale. The detailed soil survey work was a one-inch scale, and is regarded as accurate down to about ten acres. We then found that there was further territory involved and covered the territory shown by adjudication maps west of Umapine. And later on the area above Milton was added. (R. 1006.)

First we requested Youngs and Professor E. F. Torgerson to make an irrigability classification. Later I came to the field and we worked that over to a water requirement classification. The detail is not sufficient so that you could correctly estimate the number of acres of any particular class of soil for any individual tract. I wouldn't undertake it. I have referred to the great climatic soil groups. These are divided into subgroups into series comparable somewhat to breeds of livestock. Then the unit of soil classification is the soil type. Based on the series name and its characteristic, and also the texture of class and independent of the soil series, we may place all the soils of one textural class in one group and speak of the "textural class". (R. 1007.)

To some extent that is what is done in an attempt to group soil survey types into water requirement groups. We inherited the six groups Youngs has used by starting out with the six groups defined in the Reclamation Bureau's Fact Finder's Law of 1926, which we used a great deal in classification. That is what these groups are based on to an extent; class 6 is eliminated land; class 5 is normally temporary eliminations; class 4 is water-logged lands in the Fact Finder's definitions. (R. 1008.)

Organic matter is very important from the standpoint of water capacity and important in determining the soil's nutrient supplying power. In Frank Eiffert's class B lands we found 6 per cent organic matter, and in some of the bench lands it ran two or three per cent. There is a class which Youngs put in as class 4 and 1-D which generally covers greasewood and salt grass lands. With the aging of the soil the soluble materials move down stream or are drawn to the surface. On higher low terrace they may accumulate in the subsoil and cause it to cement and develop a hardpan, an alkali hardpan. The hard greasewood lands are low terraced lands in class 5; it is hummocky, alkaline, of doubtful economical value. The salt grass land has more surface water I think and more sub-irrigation; it is more affected by water and perhaps darker in the native condition. (R. 1009.)

In the upper reaches of the stream where it occurs it has been laundered out to some extent so there is present some native clover, some blue grass and other of the more palatable grasses. In the lower country, below the vicinity of the Whitman homestead, the class 4 land shown in the soil map is largely idle, or nearly so. Hard greasewood land, some salt grass—but greasewood prevailing—as you go down stream. Some of that land has been fitted for irrigation, and part of it has gone back to greasewood. We made some mechanical analysis and some estimate of the amount of gravel in the No. 3 lands. In the Miller orchard a quarter of a mile west of the McCoy bridge we found that six inch cubes yielded on a quarter mesh screen from 63 to 79 per cent of gravel, cobbles, and stone. First a cube was taken six inches down, then a second six inch layer, then a third, and it ran from 63 to 68 to 79 per cent retained on the quarter mesh screen. This land is in the southwest quarter of the southeast quarter of section 24, township 6 north, range 35. On the H. F. Eiffert ranch in the southwest quarter of the northwest quarter of section 14,

Tp. 6 north Range 35 East, I made a test. That was class 2-B land. Where we tested it was 16 and 14 per cent gravel. That is the next grade to the No. 3 land. On Warren Roeder's land in the northwest quarter of the northwest quarter of section 36 township 6 North range 35 East, one area showed an average gravel content of 49 per cent; another area showed average gravel and stone content of 66 per cent, and then very fine earth. That was in the first six inches. The tendency would be to coarser gravel rapidly increasing with the depth. (R. 1010, 1011.)

The fine material that went through the sieve in this land was 52 per cent sand, and that did not include the very fine sand that went with the silt and clay, so it could not be loam; it would be a sandy loam soil. On the Sunnyside project in the class 4 lands, by mechanical analysis we found the fine soil to be 57 per cent sand and clay. That would make it a silty clay loam, and would have a greater water holding capacity than where it was from 49 to 66 per cent gravel. I made tests to ascertain the excess point and wilting point of the No. 3 lands. In doing so I made a correction for it according to the percentage of gravel. If there was two-thirds gravel and wilted at nine per cent, the fine earth would be one-third of it and we would estimate the wilting point at three per cent. You can only determine the wilting point on the fine earth in cans in the greenhouse. The only practical way to determine the wilting point is to take the fine material going through the mesh and determine the residual moisture. That fine earth gave gravel around seven per cent for the coarse class 3 material. We made excess-point determinations by sampling a day or two after irrigation of the fields in the main classes; also by moisture equivalent determinations which approximate the proper excess point. A field sample may be a little too high. Usuable water capacity would include moisture stored in the soil between the point of permanent wilting or just above it as the lower limit, and the moisture

equivalent approximating the higher field moisture contents that you would find by the time the soil was dry enough to mulch or seed; you then have had the water present long enough to be in equilibrium with the soluble material in a solid phase, so it would really be of nutrient value to the plant. (R. 1012, 1013.)

A great many determinations have been made of usuable water capacity for different classes of soil. For fine sand they would establish about one inch. A medium coarse sand at the Umatilla station runs two-thirds inch usuable water, but it is similar at six feet or more depth there. It is only the heavier soils that will hold more than two and a half inches in a foot usuable water. I once prepared a graphic illustration of that capacity in a bulletin in soil science. On the graph—exhibit 43—the heaviest lines are marked to indicate the wilting point, and on the other end the moisture-equivalent or excess point. The spread between indicates the inches of usuable water for different classes of soil. The "optimum point" is a range. In making the tests it is necessary to have the weight per cubic foot in order to convert the moisture percentage into acre inches. If the soil weighs 80 pounds per cubic foot and you have ten per cent usuable water between the wilting and the excess point, that is 8 pounds of water. To convert it to inches depth on the surface per cubic foot (or per acre foot) it is necessary then to divide by the weight of an inch foot, or 5.2 pounds, an inch foot being one inch deep over one square foot. (R. 1014, 1015.)

In my examination of the soil the ordinary depth of usuable soil in No. 3 lands of the Milton fan shows the most storage capacity in the first two feet and the first three feet, and in this class 3 (Stony-gravelly land) it is on the order of two or two and a half inches. The Bureau designates gravel from two millimeters to three inches in diameter, and cobbles from three to five inches, and above that, stone. The useful soil depth is largely within the first two

feet, but there is some value in the third foot. For a good growth rate we should have usuable moisture in the bulk or major part of the feeding root zone. As to vegetables, small berries, the active feeding root zone is less than two feet; maybe one and one-half feet. The trees which had been pulled out indicated the feeding root zone to be largely in the first two or two and a half feet. The roots are stubby and spread out close to the surface. I presume the lack of moisture in the cobble stones underneath limited the root development. Apparently they are securing their moisture in the surface two feet or so. In our study of pear orchards in southern Oregon it showed that 68 per cent of the pear roots are in the top two feet of soil. They have extracted 62 per cent of the moisture from the first two feet, and 84 per cent from the first three feet. Studies in Orange county, California, showed that 50 per cent of the moisture is taken from the first two feet with citrus trees. The soils around Milton have rapid drainage. (R. 1016, 1017.)

Going down stream to the low-terraced lands we find imperfect drainage. Here you find the salt grass and greasewood developing, and find salinity and alkalinity and alkali-tolerant growths. The greatest area of salt concentration is, as usual, down stream. The reaction value of pure water is 7.0; lime water or highly calcareous soil may be as much as 8.5; alfalfa will be affected at about 8.6 or 8.8. Salt-grass lands here locally commonly run 9 to 9.6; and greasewood land commonly 9.5 and higher. We eliminated in feasibility surveys land with a reaction value above 9 or nine and a half. Good authorities consider there should be 10 or 15 per cent deep percolation to avoid accumulation of toxic salts. (R. 1018.)

It would be in the order of safety to have a moderate amount of drainage and a sufficient application of water on the surface to procure it. (R. 1019.)

There have been orchard fertilizer experiments at Miller's and at Eifferts. They had apparently been picked

as fairly representative and had some accurate data as to yields and response to different fertilizers. The prunes there responded not only to nitrates but to complete fertilizer, which shows that potash is a factor. The irrigation requirements would be different in different classes of soils. Generally the coarser the soil the greater the requirement. I made something of a study of the requirement of water to be applied at one irrigation on the No. 3 lands. It would be difficult to apply less than a five-inch irrigation, and perhaps two and a half to three inches of it might be retained; that is an acre inch or depth on the surface. (R. 1020.)

I refer to acre inches to an acre. Assuming the application of five acre inches to get over the number 3 lands on a continuous flow for the critical months, it would require an inch and a half miner's inches to the acre. The most important factors in my consideration are the usuable water capacity of the soil and the time between the soaking of your land and when the crop shows a tendency to wilt. It is better to irrigate a little before the wilting point when the soil moisture films are still thick enough that they are not too lightly held by the soil at what has been called the lent-point where a plant tends to be slowed up in its growth before actually wilting. We have found much better results where we maintain a good moisture content than to allow the trees to wilt at each irrigation. This is particularly true in cooperative irrigation investigations at Medford. (R. 1021.)

At Medford one block of pears was allowed to reach permanent wilting percentage and then was irrigated; another was given frequent irrigation through the season. With frequent irrigation there were 1034 pears per tree as against 731 where the moisture dropped to the wilting percentage, and the volume of the pears was 180 cubic centimeters with frequent irrigation, as compared to 143 where the trees were allowed to wilt. With frequent irriga-

tion they were 30 per cent larger and there were three times as many 120's, which is the larger size pack of pears. And the tree growth was 40 per cent better the following July as to the length of new growth and the diameter was 30 per cent more. Frequent irrigation gave the larger pears and that is the experience in other places where it is carried on. (R. 1022.)

The last 40 days before harvest is especially important in getting size and yield, and that is true and has been reported in several other state investigations. Batcheller, in Utah Bulletin 142, found that on gravelly soil peaches must be irrigated every seven or eight days, and he obtained more twig growth and a higher color by late irrigation.

Viehmeier, in California Circular 50, reports no injury from later irrigation, but that both leaves and fruit are affected when the moisture is allowed to drop to the wilting point. The trees then grew more slowly.

Abell, in Utah Bulletin, 202, states that allowing trees to suffer for water is an invitation to winter injury. A shortage of water seems to make the trees more susceptible to disease. In this valley the red spider does more damage where trees are on dry and dusty soil. (R. 1023.)

I have observed the water supply in this district and the whole northwest over a period of years. We have had a period of dry years according to hydrographic records. Numerous streams have gone dry, and lakes in central Oregon have gone dry—Silver Lake was half a township or so in 1915, and the bed of it has been dry recently. I think there has been a general decrease in the water supply. A decrease in the yield of alfalfa on the Gardena project from the time it was started is in line with the general experience. We encountered that condition on the Sunnyside project. (R. 1024.)

There are a great many reasons that are known, and some unknown reasons. (R. 1025.)

APRIL 30, 1934

Powers—Direct Examination

(Pages 1127 to 1134)

I was in the Bureau of Chemistry and Soils in Washington, D. C., on leave during the winter of 1930-1931 doing research work on soil colloids. I took my doctor's degree at California, studying there in 1923 and 1924. (R. 1127.)

While there I studied plant nutrition and soil. I finished my thesis after my return and got my doctor's degree in 1926. The colloid fraction of the soil includes the very fine particles both inorganic and organic. We can say clay jelly, peat jelly, or humid jelly. It increases with the fineness of the soil. Normally there is much more in the heavier soils that are higher in clay content. (R. 1128.)

I have found my old field book for Sunnyside. On Saturday, September 19, 1931, Johnston and I were in Section 31—9 north—24 East in the gravelly basalt area. I have notes from 15 test pits that we dug. On a type sample for basalt gravel land near the West quarter corner of Section 31 the profile description read naught to nine inches brown, fine sandy loam, but we were mistaken; when a mechanical analysis was made the soil proved to be finer than our field estimate. There was 57 per cent of silt and clay so that the difference really was a heavy loam, or light silty clay loam. The topography there was smooth. The ten to eighteen inch layer was brown, heavy, and compact, showing some maturity and good development. B-layer or zone of accumulation in the sub-soil was estimated to be from twenty to thirty per cent basaltic gravel, and from eighteen to twenty-seven inches was similar material with a little increase in size and percentage of gravel. (R. 1129.)

A soil to be sandy loam must contain from fifty to eighty per cent of sands. Over eighty per cent sand and less than fifty per cent would be a loam or something heavier, so that according to the mechanical analysis of the type

sampled the soil would be a light silty clay loam on the surface as compared to a fine sandy loam texture for the class 3 land here. The other 15 borings indicated that the land there is subject to seepage in places and with an occasional basaltic outcroppings. There are pockets and layers of sub-angular or slightly rounded tufacious basaltic gravel or lava ash. It is porous, carries water some, but is not deep and the general deep sub-stratum there is certainly basalt. The colloid content in this type of land at Sunnyside compared with our Number 3 lands would be fairly similar to plow depth. The colloid content of basaltic land is on the order of twenty per cent for the first two layers, and would certainly be definitely less in the second foot here. Up there there is definite accumulation of the fine parts of the two soils in the second foot. (R. 1130.)

Here in the No. 3 land it becomes coarse and open very rapidly. The Sunnyside soil would have a higher water capacity in the first two feet appreciably higher. Both would have a fairly rapid drainage. I formed an impression that our sand at Sunnyside used more water than the gravel soil unless in some few pockets. The soil here would certainly use more; it is coarse sandy soil. [illegible] Sunnyside a week. (R. 1131.)

West of the Whitman Homestead the minor part of class 4 lands has been in years past cleared and checkerboard dikes built. Much of that land has gone back to sage brush, greasewood and salt grass. Much of the area is unleveled, in native condition, rough and hummocky, except for some good loam near the river. That class 4 land is largely unimproved.

I examined the Welch place near Lowden. Most of the land north of the river, about 20 acres out of the 35, is in native condition; unleveled, greasewood land, rough surface with white and black alkali spots in places. (R. 1132.)

The fertilizer experiments at Eifferts and Millers had run for two years when I was there in 1932. If they were both maintained they would be correspondingly older.

CROSS-EXAMINATION—POWERS

On the Yakima project the soil down to plow depth would be a little lower in organic matter than the improved class 3 land here, but the organic matter would not carry down as well here as it would there. I made a reconnoissance of the area of number 3 soil on Mill Creek. (R. 1132.)

I saw deep cuts in the material, and at the end of Isaac Street there were numerous excavations for water mains and storm drains. I think a little lower and right up above the city boundary there would be more colloids in the soil. Certainly it is unlevelled and idle land. The soil marked orange on Washington's Exhibit 15 near Milton, and the soil marked orange at the top of Mill Creek—in my opinion—are not the same. The soil at Mill Creek is more droughty, and is practically waste land having gravel pits and dumps. Most of it is unleveled and dry and of extremely coarse texture—a quarter of a section or so. With the exception of this land, I think the No. 3 lands on Mill Creek would in a rough way have the same requirement for water as the No. 3 lands on the Walla Walla. (R. 1133, 1134.)

POWERS—CROSS-EXAMINATION

The soil between the rocks and gravel in No. 3 soil I regard as recent alluvial material. We speak of maturity, as soil ages ago, it comes to have a layered profile, like a piece of layer cake, a leached surface layer and a zone of accumulation below it on top of the parent material. In the Milton and Freewater area in the No. 3 soil, there has been heavy manuring and disking in of alfalfa into the surface soil, and the organic content is rather good, and in the sub-soil there is not so much. The first 6 inches to plow depth our test indicated on the order of 5 or 6 per cent organic matter. (R. 1025.)

The gravel size tends to increase vertically in the No. 3 soil; there are more cobbles in the sub-soil. Generally, but not always, it gets larger as you go down. If the soil in the

No. 3 area between the rocks extended down 5 or 6 feet with the gravel well filled with fine earth of good quality that would be comparatively productive soil. Wash gravel and a high percentage of stone would limit the fertility. The point of permanent wilting is determined by growing sunflowers in fruit cans, and we transplanted the sunflowers sealed in it until they are not revived when placed in a saturated atmosphere for a period; in a humidor that is kept damp or at a humidity near a hundred per cent. That is checked by taking a sample in the field where the growth shows wilting and can be indirectly determined further by a factor that is fairly reliable for most soils from other critical moisture points. Then your excess point can be determined from moisture equivalent tests, subjecting small samples to a force of a thousand times gravity in a centrifuge for a half hour, and then determining the residual moisture. That practically checks up with your excess point that you find under field conditions from the time you go upon the land to seed or mulch time after irrigation and left to soak. That can be further checked by saturating a core of soil in its natural field structure and draining it to constant weight, and then sampling that, but the value you get then has to be corrected by a factor. It is about a quarter too high. (R. 1026, 1027.)

We determined the 25 per cent error by field results and laboratory results by taking thousands of moisture determinations on uniform soils that we are very familiar with and making that study and arriving at a factor, which I will say is an approximation, but based on a large number of determinations. We have made 10,000 moisture determinations in one season in the Willamette valley and the excess point is about 27 per cent, and a point where it gets dripping in a permanent saturated atmosphere is near 34 to 36 per cent. (R. 1027.)

The orchard irrigation investigations of recent years indicate it is better from the standpoint of tree growth and

perfection in yield and quality to irrigate before the soil reaches the wilting point. In determining the fertility of the soil in these orchards there was a regular analytical fertilizer experiment in each of the two orchards for two years. They applied the fertilizer on the land and measured the yield. Ten or 12 plat fertilizer experiment, a dozen trees to a plat were run and then we analyzed the soil. That has been taking place for three or four years. I feel that on the No. 3 lands they should be irrigated about once a week for tree crops, and for tomatoes at least twice a week to prevent wilting. (R. 1028.)

If the water supply was cut to one miner's inch I wouldn't ask—where the ownership is a 7 acre average—that they be equipped for very many different crops. There is always a little room for improvement, but there are economical limitations. The amount of one and a half miner's inches continuous flow as I have suggested is an unusual amount of water, but it is for a very unusual soil. The unusual conditions which I have considered is the very limited usable water capacity, and no ground water within a distance that will help meet the situation for the roots, and a long, relatively hot growing season and intensive farming. (R. 1029.)

In our experiments at Medford we were surprised that we had good results with more water than was anticipated. You can drown out some crops; some are more sensitive to excess water than others, and drainage conditions will help determine how they will grow. The period of dry years we have had enters into my determination as to the amount of water the people should have only in a general way. Forest fires and over-grazing reduce the litter and hasten the run-off. On the No. 3 soil early in the season dust carried by the wind and water may coat over the furrows and then penetration may be a little slow. The organic matter aids the penetration and lateral spread of the water applied. (R. 1030.)

Water will not go sideways much as long as it can go down. I think that the spread would not be good as long as the ground is open below. There is nothing unusual in the soil between the rocks that would require more water than in soil of that texture anywhere. The rocks hold nothing if they constitute three-quarters or two-thirds of the volume; the reservoir is then very limited. The soil between the rocks would permit a lateral spread of water, but it would have to detour around the rocks. (R. 1031.)

POWERS—RE-DIRECT EXAMINATION

Land that is sub-irrigated would be benefited by the upward movement of moisture, but here in the coarse gravel the water drips through and runs away, and there is practically no wick action. The water doesn't climb back in the capillary attraction and the ground water is deep enough that the roots do not benefit from it. I have seen quite a bit of the preparation of ditches upon lands here when getting ready for irrigation. In the last few days we saw most of the ditches being cleaned. (R. 1031, 1032.)

In 1914 when I first became acquainted with this district there were good bearing orchards here then. I believe from my examination of the district and continued knowledge of it that they are using their water fairly well, comparable with other districts. I would consider the methods of irrigation and the irrigation practice reasonably efficient, and fairly comparable with what reasonable irrigators use in other places for similar soils.

I think that four-sevenths of an inch, Oregon measurement, with continuous flow would be required to irrigate the 1 and 1-R and 1-D soils. (R. 1033.)

I speak only of farm duty; at the farm headgate. The 1-R I segregate partly into 2-T, being the second class the topography being rather steep and somewhat broken it might need a little more water, two-thirds of an inch where the other had four-sevenths. For Youngs 2-A class there is

required about seven-sixths of an inch. The 2-B class is only 6 inches to gravel, the furrow opens most of that, and it should have the same amount of water as the 3 class. It is impracticable to have more than a few duty classes. Youngs soil map covers both irrigated and non-irrigated lands. He took in too little, and then he took in too much. That is the pink color, and some of the 1 below Walla Walla is hummocks or hillocks that have never been leveled and are dry. A great deal of the 5, and below Whitman homestead a great deal of the 4 are unleveled and unfitted for irrigation. And above the city of Walla Walla I estimate there are 80 or 100 acres of waste lands, gravel pits, and city dump grounds and about a half section or more of dry stony land that is practically idle. We eliminate land that has a reaction value above 9 to 9.5, hard greasewood land. We have eliminated close to 50,000 acres from Oregon projects in the last eight years mostly on that account. The irrigation methods and diversions on the Washington side are similar to that on the Oregon side as to efficiency. There is some very crude irrigation down below Whitman's homestead, in the vicinity of Lowden. There is no particular difference in practices on either side of the line. (R. 1034, 1035.)

RE-CROSS EXAMINATION

I have not observed the measuring points from the natural streams; I have left that to the engineers. (R. 1036.)

Wilbur L. Powers

DIRECT EXAMINATION BY MR. COCHRAN
(1171 to 1173)

The West City line of Walla Walla apparently is the west side of Section 18. It comes to the center of 19, and from the center of 19 in 36-7 runs West a forty, and then down to the bottom of the section; then the city apparently

joins the United States Military Reserve where there is a remnant of a fan extending beyond the limits of the city to the west. There are a couple of little areas of three land north of College Place, also in Section 23. The area lying in the southern part of the orange shaded district has the south eighty in the SW¼ of Section 29, which is apparently the fairgrounds. Most of the next forty east of it is within the city. The Southeast forty in Section 29 is apparently outside of the city, and according to the map, a small part of it would be class three. (R. 1171.)

There is a little No. 3 land in the north part of Section 32 which is apparently outside of the city. The fairgrounds is apparently in the South half of the Southwest quarter of Section 29. (R. 1172.)

Oregon's Exhibit No. 45—a list of bridges across the Walla Walla river and their locations, was then introduced in evidence.

F. A. Fullerton—Examination

(Pages 1037 to 1041)

I live at Milton and I am business manager for the city water department. I look after the business end of the water department. We have a record of the metered use in the city. (R. 1037.)

I made a hurried examination today of these records. They show a variation in the total metered use per day. For January, February, March and April it shows two million gallons a day consumption. In the summer months when sprinkling and irrigation goes on there is a consumption of from three to three and a half million gallons per day. August was the peak month. From April to the peak in August we have a graduated raise from two million gallons to three and three and a half million gallons per day. (R. 1038.)

CROSS-EXAMINATION

None of our users are metered. We have a total meter of the water before it is sold out to the patrons. It is a main-line meter and measures all the water that goes into our mains. It is located at the head of our main just below our chlorinating machine; below our new power plant, but above our old power plant and almost directly at the new power plant. It is a Sparlin flume meter and operates continuously.

We don't have an absolute record every hour of the day, but it is read every day. After the water is metered in it is distributed to the consumers and there is no point between the metering place and the distribution to the consumers where water is turned off to a stream. The water is used for household use and for irrigation of lawns and small garden plots; for sprinkling purposes on the gardens. (R. 1040.)

Our regular charge is $1.50 per month and in the summer we have a sprinkling charge of a minimum of 35 cents at the rate of 70 cents per 100 square yards. We measure that at each man's property having a record at our office of the size of each man's property and then determine the charge for sprinkling and the number of square yards there. (R. 1041.)

RE-DIRECT

The water passing through the meter is not passed into the flume for the operation of the old power plant. It runs into our city distribution system and is not returned to the stream.

S. T. Harding—Testimony

(Pages 1043-1099)

I am an engineer living at Berkeley, California. Graduated from the University of Michigan with a B. S. degree in civil engineering. (R. 1043.)

Since being out of college I have specialized in irrigation from 1907 on. My experience includes instruction, preliminary investigations, water supply study, land classification, and water requirement work particularly. I was three years on construction work with what is now the United States Bureau of Reclamation, and in later years have been consulting engineer for them, on the adjudication of the Truckee river for the Newlands project in Nevada, and Stony creek for the Arland project in California. I have been consulting engineer for districts operating projects built by the Bureau of Reclamation, such as the Sunnyside Valley Irrigation district in Washington, the Truckee-Carson district in Nevada; the Verde-Nevada Irrigation and Power district in Arizona. For three and a half years I was in charge of irrigation investigations for the United States Department of Agriculture in Montana and have done work for them in Idaho. (R. 1044.)

I have been consulting engineer for the Federal Land Bank of Berkeley on water supply questions in various counties in California; for ten years from 1920 to 1929, and to a lesser extent to date I have been consulting irrigation engineer for the state engineer of California handling studies of water supply feasibility districts, questions of water requirement and land classification. With that public work I have been engaged in consulting practice for other forms of organization, including land classification, water requirement matters for the city of Santa Barbara, and Los Angeles, the Los Molinos Land Company and other organizations. (R. 1045.)

I am professor of irrigation at the University of California giving some of their courses in irrigation, practical

operation and maintenance, irrigation and organization, and institution. My experience includes experiments in irrigation under field conditions. (R. 1045.)

For two seasons in Montana we took land on farms and measured the water applied and the yields obtained trying to determine the effect of variations in water supply on the yield. On the Minidoka project in Idaho in 1915 I made a similar study of water requirements on sandy types of land. In 1917 I made a similar study for the Sunnyside division of the Yakima project to determine reasonable use for the different types of soil on that division. I did similar work in connection with the Truckee river adjudication, where we took selected lands and operated them under measured quantities of water observing the effect of the difference in quantity on yields and frequency of irrigation and the amount necessary to apply at each application.

I arrived here on March 29th (testimony given April 5th), and have spent the time since then until now in field observations, going over the data collected for the case, examining the exhibits and testimony, and other records. (R. 1046.)

I have studied the decrees involved and the test places. I visited each of these test places and made a general study of the other areas. (R. 1047.)

I have studied the soil map and the under-ground water studies. I examined certain of the pits and the channels to determine the soil structure. I had copies of the soil map—Exhibit 15—with me on my field trips, and, in a general way, the soils indicated on the map are correct. I think the map is sufficient as a soil map. It is not and does not include all of the details needed in a study of water requirements, but as a basis of the character of the soils and their location I consider it very good. To determine individual ownerships and water rights for individual duty it would need to be supplemented by consideration of individual ownerships and priorities. (R. 1048.)

Some additional detail would be needed in fixing water requirements for individual farms. The prevailing soil around Milton and Freewater is extremely coarse in texture. The soils vary and in nearly all areas there are lands of different types, but in the cone that extends outward from the mouth of the canyon near Milton the upper portion is practically all of very coarse, gravelly, or stony character. In considering duty of water I gave consideration to the texture of the soil as I found it and as indicated on the map. I made a general examination of the water supply; went over the general reports of the stream flow, and Piper's report on under-ground water. I made no detailed analysis of water supply, but examined the records generally. (R. 1049.)

I find the run-off typical to that of many streams, diminishing in the later summer months and the area the stream can serve is largely defined by the supply of these months. In some areas the ground water is near enough to the surface to affect the water requirement of the land. The water table, if sufficiently close to the ground surface, will permit plants to utilize the soil moisture, or where in the depth of soil it has to be moistened at each irrigation. This affects the water requirement of the Oregon lands. If the table is too high it may limit the root zone of the plant and be detrimental to both crops and water use. So far as I could—at this season of the year when irrigation generally is not yet going on, I studied the irrigation practices of the district. I studied stipulation No. 3 on irrigation practice; I read the testimony of the witnesses who operated lands on the test places; I observed the character, the condition of the lands, and the irrigation systems in the field as far as I could at the present time. I observed the furrows as far as I could. Ditch cleaning and furrow cleaning is in progress now in some areas. I could see generally the length of the furrows and the testimony of the witnesses covers the practice which they follow during the summer

period. In my opinion, the practices—considering all of the local conditions—are representative of reasonable practice and reasonable use. Practice which is reasonable varies with climatic, crop, water supply, and economical conditions. The general character of practice as to length of furrows and the arrangement of the land is representative of that usual under similar conditions. The grade of the land affects the length of furrows. The size of the furrows indicates the heads that could be turned in them, and seem to be as large as could be handled efficiently. (R. 1050.)

With the furrow method the irrigator can use smaller heads of water than with the flooding method. He can adjust the furrows which he runs at a single time to the head of water which he has available. The slope of the furrows which usually run down the steeper slope of land is enough to give a fairly good flow through the furrows. The testimony indicates that the users turn in a reasonably large head into that furrow, and that it works through the length of the furrow in a time shorter than those in some areas following the furrow practice for similar crops. I consider the practice of having a tail-ditch to catch the overflow of the furrows and then convey it to other land or another head ditch to supply other furrows lower down, is a proper, reasonable and desirable practice. It is desirable to crowd a large stream through the furrow in porous soils as quickly as practicable so that the entire length of furrow may get a similar period of time for absorption. Crowding a larger stream through will result in some waste at the lower end, which it is a good practice to pick up and redistribute into lower furrows. (R. 1052.)

The method employed here is very generally used in the northwest. I worked on coarser soils in Sunnyside, Minidoka and the Truckee river area and while each of these projects have coarse textured soils, I do not consider that their soils are as extremely coarse as those found on the main gravel cone here. (R. 1053.)

They, therefore, would not directly furnish a standard of practice for this district, but would furnish information useful in comparison. As far as I could—by observing the general condition of the channels and the available records – I studied transportation losses but made no measurements of my own. I have made measurements and studies of seepage losses in other districts. (R. 1054.)

Seepage loss varies with the material with which the channel is constructed and the size of the channel. The percentage of loss per mile in some material is higher in smaller channels. Here the river is divided into prongs or channels natural in origin, and which run through coarse material. From the size of the channel and the water carried as indicated by the record, I consider a 20 per cent conveyance loss as reasonable and such as one would expect to find with channel conditions in these soils. I observed the ditch systems in the field on the places visited. (R. 1055.)

At present their condition is variable; some have been cleaned out and some have not. The natural channels go down the cone generally on the steepest slope, approximately 1 per cent. The first farm turn-outs take out at right angles on a rather flat grade and the furrows then run on the steeper grade. The farm ditches taking out on the flatter grades catch some of the silt in the water, and grass growing in the ditch helps this practice. Some of the ditches recently cleaned showed very little gravel, the silt occupying most of the ditch bed. This would give a lower rate of seepage from farm ditches than would occur from the furrows which are not silt. The farm ditches prepared for this season's operations are typical of ordinary earth channels for farm conveyance, using the size of heads which are the practice here. The average size of farm is small, which results in a relatively short length of farm ditch. Many of the farms divert directly from the natural channels and have a lesser length of farm ditch than is usual in most areas. (R. 1056.)

The natural channels in effect take the place of the laterals in the ordinary system. I studied the Oregon decrees relative to the amount of water fixed for beneficial use. It would make a difference in operation where the natural flow of the stream, rather than storage is depended upon. Whether it would be necessary to carry these differences into the decree would depend on local conditions. With storage in a dependable amount sufficient to remove shortages, use can be figured on a steady demand basis to a greater extent than where the supply is subject to fluctuations of the natural stream flow. (R. 1057.)

The seepage losses mentioned in the decree were the Pleasant View canal, where 20 per cent is allowed, and in the Hudson Bay ditch an allowance was fixed on the historical record of diversion which would supply a seepage loss.

The decrees fix a maximum diversion with a limit to reasonable use and is the usual form of such decrees. In streams where storage is important the decrees often fix a total quantity that may be diverted during the season. In the decrees that I am familiar with that has been done, and a maximum rate of diversion fixed based on the water requirements of the land during the month of maximum demand. Here that would be July and August. (R. 1058.)

The rate of delivery during that period determines largely the results and yields the farmer could obtain from irrigating crops maturing late in the season. With a shortage of water during these months crops which can be matured with water during earlier periods would need to be grown, or pumping plants or other substitute sources provided. The acreage which can be given full service from the direct flow of the stream is limited to the area which it can supply during the period of maximum demand. On most streams supplied by melting snow or ground seepage of the drained area which comes from melting snow, the maximum crop demand comes at a period of minimum

stream flow. In determining duty of water frequency of irrigation is of primary importance. The amount of water an irrigator needs depends on the amount with which he can cover his land at each irrigation and the frequency with which he has to cover it in turn fixes the total amount of his use during any period. Frequency of irrigation required is ordinarily fixed by the practice and experience of those actually irrigating the crops. The land owner may not be familiar with methods of measuring water so as to determine or know the quantity of water which he uses, but I have found in all of my experience that actual irrigators can and do know the frequency with which it is necessary to irrigate for different crops, and that water requirements can be built up from that frequency to the required amount to be applied at each irrigation. (R. 1059, 1060.)

The irrigator is in the best position to determine any injury to the crop from too long a delay in the times of irrigation, and has a more constant contact with the soil and the crops than is obtainable otherwise. Here for soil No. 3 frequent irrigation is necessary. Stipulation No. 3 and the testimony of witnesses on the subject indicates a frequency of seven days on the gravel soil for tree crops with the usual type of cover crop practiced here. While I have not been here during the irrigating season to check that directly, mere general observation of these soils would indicate that whatever the frequency is, it would necessarily be relatively short. (R. 1060.)

I was not at all surprised after examining the soil to find the record showing irrigation at weekly periods to be necessary. (R. 1061.)

I would assume that stipulations fixing that period and the testimony of the land owners represents a reasonable result of their experience. That period is relatively short; shorter than the frequency I have found in other areas in soils, except those of very heavy texture or shallow depth

of impervious sub-soil. I have found lands where it was necessary to irrigate as frequently as seven days, or where soil is heavy clay in which only from two to two and a half inches can be absorbed at an irrigation, and which can't carry the crop for any longer period of time. I have also found that frequency used on shallow soils over impervious sub-soils where a similar moisture capacity occurred. It is also at times found necessary to irrigate pasture crops of shallow rooted grass at relatively frequent intervals on soils of better texture, but for deep rooted crops, such as those mainly grown here to which the seven day period applies, that frequency is shorter than is generally required in other areas. The soil itself is coarser than the soils where I have found longer periods usable, and the seven day period appears consistent with the ten to twelve to fourteen day periods of frequency in areas of other coarse soil. The seven days I mention applies to tree crops with cover crop. (R. 1062.)

The record indicates that for tomatoes and shallow rooted crops a shorter frequency is needed. The record indicates that two and a half acre inches are retained in the soil after each irrigation within the root zone. That would be comparable with water retained in the soil in other places where frequent irrigations are necessary. The fact that frequent irrigations are required is an indication that soil does not retain much water from each irrigation. The crops grown here would be expected to have a consumptive use of moisture and by evaporation through the soil of about that amount per week during the main summer months. The fact that irrigation is required with that frequency checks, in a general way, the material regarding the moisture capacity of the soil. If these soils could retain much in excess of that amount of water from an irrigation they would not need irrigation at such frequent periods. I studied the amount of water required for a single irrigation as well as I could at this time of year from the records.

My conclusions are based upon the general observation of soil texture and experience in other areas. The testimony of the landowners as to the number of furrows they run, the time water remains in the furrows and such other information as I could collect at the present time. (R. 1063.)

The soil is relatively coarse, contains a large percentage of gravel and rock fragments of larger size. The finer soils within the gravel reaches from medium to fairly light texture through which water would move readily. I found from the information obtainable that the irrigators use from five to six inches depth of water for irrigation, which is about what I would expect to find necessary to get over these lands with the length of furrows and the methods employed, and I consider that a reasonable result. As to the depth of soil that retains moisture for tree use, that diminishes from the surface downward. There is a larger percentage of fine earth material in the upper foot to 18 inches, becoming less below, until below three feet there is practically no soil useful to the plants, so the moisture storage capacity from an irrigation is limited practically to what the soil could retain within the upper three feet, and that more largely in the upper foot to foot and a half than in the full three foot depth. (R. 1064.)

I saw some trees that had been pulled out and the general character of the root growth was shallow. They spread largely in the upper two feet or foot and a half of the soil, which indicates that the tree has adapted its growth, as it usually does, to the depth of soil to which moisture is most readily obtainable, and in this area that was the surface soil. I made no direct tests to ascertain how much of the water would be retained in the soil, but I have studied that proposition in other places, and from that information I formed an opinion, having made a good many of such studies involving many thousands of soil samples as to the moisture content of soils before an irrigation and after, so

that the amount of moisture could be determined. The soils here are clearly ones of limited moisture holding capacity. If the soils can only carry for a week's time from an irrigation, and from five to six inches are applied at each application, obviously the difference becomes deep percolation. (R. 1065.)

With five to six inches depth of irrigation and from two to two and a half inches useful water it leaves 50 to 60 per cent for deep percolation. Evaporation should not be much because of the general shading of the cover crop. The transpiration of the cover crop to an extent balances the saving in evaporation. The two and a half inches consumption includes evaporation as well as transpiration from the trees. The figure of two and a half inches checks to my experience in other areas on the land to which water is applied and consumed where soil conditions are such that percolation losses are less. We have many areas in California where the general practice physically is similar to that here. Water is used liberally in the early season when available. The ground water is built up and later drawn down by pumping, and studies there indicate that the amount of moisture secured in transpiration and evaporation is about the amount which I have stated as my estimate applying here. (R. 1066.)

The frequency of irrigation by soil test experience in other places and the transpiration of moisture in July and August coming from crops raised at that time check and indicate that two to two and a half acre inches of water is retained by the soil after each irrigation. To deliver that amount of water a five to six inch irrigation weekly is applied and we make some allowance for loss by seepage in farm ditches. It works out closely to an inch and a half per acre continuous flow using the Oregon value of the miner's inch. (R. 1067.)

I have studied water requirements of the coarse soil. I paid little attention to the coarse soils in the Washington

portion. In Oregon they occur in a fairly compact and solid body extending into and out from the canyon of the Walla Walla river near Milton and Freewater. There is another area near the state line east of the West Prong generally of similar coarse texture. There are others scattered and smaller, but the two mentioned represent the principal ones. (R. 1067.)

In these coarse soils it is not practicable to get over the lands by irrigation without delivering more water than the soil can retain. In fact there are very few areas where irrigation does not result in some deep percolation loss which is as much as 50 per cent in soil areas as coarse as those here. In some heavier soils the difficulty is in getting penetration, and we have almost no deep percolation, for instance, in our clay adobe lands used for rice production in California where water stands on the lands in excess of 100 days per season with practically no seepage; but for soils of medium and light texture there is very little irrigation practiced which does not result in the rise of the water table, indicating percolation from the lands as well as canal seepage. In addition to the fact that you cannot help having deep percolation there is benefit from deep percolation, but if carried to an extreme it would be injury. (R. 1068.)

It is generally considered there should be maintained some downward movement so that concentration of salts will not occur in the surface soil. To the extent needed in the qualities of most irrigation waters, this can be accomplished by an occasional deep irrigation and would not require the amount of percolation that occurs on these lands. I observed the headgates in a general way, but made no seepage investigation of them. The take-outs which I saw were heavy concrete construction, substantially built. Some weirs were installed but were not used as measuring devices at this time. I saw the construction of the frog, and the diversion at the red bridge where the Little Walla Walla is taken out from the main Walla Walla. (R. 1069.)

From a general survey of the water supply, soil conditions, distribution of the natural channels, I would say that in general the system of irrigation practices is reasonable and up to standard practice. It is difficult to define a standard of practice. We really should divide it into two parts, one the distribution system and one the use by the land owner on his own land. Here they use the natural channel to a greater extent for the conveyance of water than is customary in most areas because of the natural condition of diversion of water into various channels distributed over this area. The structures I have seen for the control of these channels represents the normal or usual type for conditions such as are found here. The channels themselves being natural, although some have been straightened for convenience and farm developments are less regular than would be the case if this area had been covered by an entirely artificial canal system. But they represent the natural development of the area under its physical stream channel condition. The farm systems—considering the size of the individual unit and other conditions—are typical of those that are found in many areas. An seven acre holding, as shown by the stipulation here for an irrigated farm for the support of a farm family is relatively small. We approach it and may reach it in some of our very highly developed citrus areas in California. It may also be reached in areas growing intensive truck or other similar crops, but for general crops the size usually considered as adequate for the support of a farm family, even with very intensive cultivation, would run 20 to 40 acres. In our central California orchard districts we would find the average considerably higher. I made a detailed study of the Peach Bowl in the Sacramento valley of California, an area comprising some 25,000 acres near Yuba City in 1931. We canvassed over 700 individual holdings as to their condition and irrigation practices, and while there were a large number of five and ten-acre tracts or units, the general size of the tract on which production and returns

were being maintained during periods of low prices, ran 20 to 40 acres, or more. (R. 1070.)

I studied the test plats irrigated by Liffert, Herman, Herr, Karker, Knopf, and Roeder. (R. 1071.)

I examined the records of experiments on the farms, the testimony of the owners and also visited each of the tracts. There were nine of these tracts distributed over the general area; all but one generally included some of the coarser soils. Bookout's soil, farther to the west is not of class 3 soil. The others in some cases were entirely coarse land; in others they were near the margin of the area and included some other soils. Six of the tracts were on the main body of the gravel cone. Two of them were on the West Prong of the Walla Walla, on the area of coarser soils in one case, and on better soils in the other. Of the six that were on the main cone, three of those—Herr, Karker and Roeder, were entirely on class 3 soils. I took the record of their use by months, averaged the amount so shown by the months of July and August for these three tracts of class 3 soils and the average was 1.45 miner's inches per acre of continuous flow for that period. Three of the tracts included some soil of either class 1 or 2-A. The Knopf tract used more water, although his soil is not as difficult to handle as the straight class 3 types. The Eiffert land also used larger amounts of water averaging in August 1.8 miner's inches per acre. Accepting their record as to necessary frequency of irrigation and taking the soil as I was able to observe it, the general arrrangement of their distribution system, I would consider the amount of water used represented a reasonable application. The West Prong decree was separate in Oregon from the main river decree. (R. 1072, 1073.)

I examined the decree as to the Hudson Bay Company and found that they were decreed a diversion of 75 second feet and for an acreage of 2600 or 2700 acres, which is equivalent to a second foot to 36 acres, or 1⅛ miners inches per acre. The lands under that canal vary from the coarser

grades in the upper portion to soils much more retentive in the lower portion. I had no segregation of the areas in the different classes and did not try to segregate them. The rates included conveyance in a longer canal than those used for the other lands in the stream, and the lands extended farther from the stream channel than in the case of any other rights. As to the Pleasant View with a permit of one-half inch per acre and a 20% conveyance loss decreed, the use of pumping plants for supplemental water supply is frequent. This is indicated by the location of the pumping plants on the general map in evidence, and by my field observations. The priority of the right is late and the supply available by direct diversion shut off in the summer season, and on the coarser soils supplemental water would be essential. The Bookout land is irrigated from that ditch. This land is much better textured than the coarser land, and relatively free from gravel in the upper few feet. Irrigation from one to two and one-half week intervals is necessary, and the one-half miners inch allowed by the permit would supply enough to give a four-fifths inch depth of irrigation at each application, and since the soils are fine-sandy-loam with a good moisture holding capacity, it would probably be covered with that rate of use. I observed the decree mentions that the one-half miner's inch allowed by the permit is apparently not sufficient for much of the land under the ditch. I think the comment refers to the gravelly lands rather than the lighter textured lands farther west. The records show the irrigation supply cut off on July 4th, to the Bookout ground. This would have a large influence on the kind of crops grown. Established alfalfa might hold through the season without later irrigation, but its yield on later cuttings would be less. If that is their only water supply it would compel them to go to general farm crops rather than orchards or vegetables. There is a well on Bookout's land. I don't know how extensively he operates it, or if he could overcome the deficiency in his stream supply by the use of

this well. The other lands under the decrees are either under diversion directly from the channels or relatively short diversions to the land itself. They are listed in the decree on the basis of one and one-half miner's inches per acre, measured at the land. The delivery from the channel is—in many cases—so close to the land that the two measurements become co-incident. (R. 1074, 1075, 1076.)

The No. 3 soils in a general way represent one-half of this remaining area. There are some lands extending up the Canyon above Milton in a relatively narrow valley. The soil map Exhibit W-15 shows them to be somewhat mixed in character, with a prevailing coarse soil quite largely 2-B class. These areas lie along the stream where any excess use of water on them would return relatively quickly to the stream channel as indicated by the testimony, and I would not consider any distinction in the rate of use would be needed for them in comparison with class 3 lands on the main gravel cone. My observations in the canyon above Milton did not go far enough to permit me to determine whether there would be any great amount of seepage loss lost from the stream, but the nature of the country—the narrow valley, the steep rise of the rocky hills on the sides, make it a natural inference that it would not cause any great loss from the stream. (R. 1077.)

The northerly lands in Oregon bounding the state line irrigated from springs and lying relatively north of the section line which goes through the McCoy bridge are affected as to their water supply by the irrigation on the cone. The actual use of water by the individual land owners is not affected. My understanding is that the distribution to these lands is separate and distinct from the distribution of water to the lands on the cone. These lands are shown on the soil map and are largely classified as 1-D and 4, both classes of better texture than the class 3. They would not require as frequent irrigation or as large amounts of use. Both of these classes generally have a water table within six feet of the

surface. This height of water table would affect the frequency of irrigation. In this area, over toward the West Prong there are some class 3 lands similar to the lands under the West Prong supply for which the water requirement would be largely the class 1-D or class 4 lands. I have not attempted to make a detailed analysis of the reasonable requirements of the individual holdings in this area. In my opinion it is clearly less than that of class 3 lands, but an actual determination of a reasonable use would involve the consideration of individual holdings, the variations in soil at the margins of the different soils classified and other detailed information which has not been available. If there should be an over-diversion there the return water would move northward. As the soil map indicates, they have a water table close to the surface. The springs rise within this area and the lands served in Oregon on the spring zone are ones on which the present use of water is apparently close to its maximum. We have full evaporation — transpiration from these lands, and any additional use would either raise the water table or move it to the north. (R. 1078, 1079.)

The flow of the springs as shown by Mr. Piper's report fluctuates in sympathy with the elevation of the groundwater in the general cone area, so that water rises in a larger quantity at the time following heavy irrigations on the gravel cone above. The lands are relatively close to the state line and the return to the water table would pass northward into the state of Washington. Along the fringe of the cone of class 3 lands there are small acreages of class 2-B lands. In my opinion it should have the same duty as the class 3 lands. The areas are small and inter-lock and overlap with the areas of class 3. The distinction is one of the soil depth containing finer material, and in view of the small individual areas I would not consider it would be advisable to attempt to make a definite distinction. On the West Prong there were two test places—the Babcock place and the Harris place. (R. 1080.)

The Babcock place is principally on class 3 land. The filling material may be heavier than on the main gravel cone. The ground water showed a depth of five feet at the time we were there and should assist some in reducing the water requirements. The Harris land is better soil. Here the owner testified that he got over his land at monthly intervals, which would indicate either better ground water conditions or better moisture holding capacity of the soil, and it would not have as large a water requirement as the gravel type. The decree on the West Prong is adapted largely from adjustments made by the individual land owners where they classified their lands with a ratio of use over one to two and one-half and issued stock in the State Line Irrigation Co. on that proportion. The decree follows that classification and makes an allowance for maximum use varying from one-half to one and a quarter miner's inches per acre to the different individual holders. The classification recognized in the decree gave to the Babcock place a second foot to 38 acres, and to the Harris place a second foot to 60 acres. (R. 1081.)

On the West Prong the water table is generally fairly close to the surface. There are some 1-D lands and some 4, but the relative proportion of these classes is less than the proportion of the same classes in the general spring area. The seepage from these lands would pass to the north. So far as I have been able to examine the conditions on the lands under the West Prong, the decree seems to be a reasonable adjustment of water requirements to the soil character. The class 3 lands given the inch and a quarter in the West Prong would not be ones of quite as high requirements as the class 3 lands on the gravel cone. I would expect a similar detailed adjustment of the East Prong to result in similar allowances or range of allowances. (R. 1082.)

How much of the area would fall into the different classes I do not have the information to determine. For all of the lands on the cone reaching down to and including the 2-B

lands I consider the present decree reasonable in regard to those lands, bearing in mind that it has a provision that the rate of use specified is the maximum use permitted, and actual use is limited by the requirements for beneficial application. In any such area there are variations, and in going over these gravel lands outcrops of coarser character are apparent, as are also spots of better than the average texture. That is to be expected, because in soils of shallow depth the necessary land leveling in preparing it for irrigation results in a variation in the depth of the surface soil. (R. 1083.)

I do not want to be understood as saying that the amount allowed in the decree is tolerable, because the amount the decree awards is the maximum and protects an excessive use to beneficial use. The point I am making is that in my opinion the allowance of an inch and a half per acre is reasonable for the larger part of the gravel cone, but that within that area, not recognized by the decree but probably existing, one could find small areas where perhaps the land could be handled on a somewhat smaller allowance, but those areas are so scattering and their extent is such that it is not feasible to distinguish them in the decree. I think the maximum allowance in the decree is itself a measure of the requirements of the main portion of the land within the area. A decree applying any uniform rate to a large area should have a rate liberal enough to cover the requirement of the main portion of the coarser types of soil. (R. 1084.)

HARDING CROSS-EXAMINATION

Piper's report shows the discharge of the springs increases in the early summer months, which is the same period when ground water above is rising. As a result of irrigation and a larger flow of water in the natural channels the flow in spring branches increases during the irrigation season. It is a combination of the two. Mr. Piper's conclusion, as I got it, is that the percolation from the stream channels is the larger factor. (R. 1085.)

The two are coincident and I do not think are separable. As to which may furnish the greater supply of ground water would be difficult to determine. (R. 1086.)

As a quotation of Mr. Piper's diagram or records platted in his report, I state that a very appreciable increase in the supply of water through the springs results during the irrigation season. My statement that irrigation above affects the supply of the streams in the spring district is also based on Mr. Piper's report. I haven't been here during the summer. Speaking of the branches above the frog, my understanding is that water flows through these branches at the winter and spring periods. At low water periods I recall testimony that there were points in these channels to which there was no flow. The silt content would be higher at the flood stages. I haven't examined the stream at flood stages and do not know to what extent it may carry silt. The water now flowing is reasonably clear. Most of the natural channels are of steep grade and gravel is exposed in their bed. I did note places where the channel has taken a turn and the velocity is checked and a silt berm had formed in the bend. Where the diversion channel takes out at right angles to the stream I found the diversion well silted. That came from the main stream; but in the main stream, which is mostly on a steeper grade, the silt would be carried through except where the water is checked. There may be—probably is to a limited extent—silt penetration between the rocks in the stream channels, that would be a matter of velocity and silt content. Even in the channels on the steeper grade there is a slower flow on the margin of the stream, and with grass growing there you would expect some silting on the sides. Under average velocities it is generally true that as a stream gets older—provided it does not change its course -the bed of the stream tends to become more silted and more compact. (R. 1087-1089.)

If the supply of water for irrigation of land on the No. 3 soil should become less, I would recommend the omission

of shallow rooted crops. There is very little general change that could be recommended. I doubt if the saving in their farm ditch system would justify a concrete lining of them. In a few instances the length of the furrows could be shortened, but the general length of 330 feet is not unreasonable and the time of from 2 to 4 hours that it takes water to work through the furrows represents a reasonably short time of run. I do not think there is any major change in the character of their construction practice which I would recommend in that area. Any such change would be largely one in their crop scheme, and if the cut of water was too great the irrigation of only a portion of the area. For all the rights under the large decree, if you were going to have a single value of water requirement, that value must be large enough to include any substantial area within the total. If you have only one limit it must be the top limit; otherwise some lands would not be able to get the water they require. While the limit in this decree, except for the two larger ditches, is one and a half inches per acre, there are lands at the north which do not require one and a half inches per acre, and, I understand, are not supplied with an inch and a half per acre at low periods from the flow of the upper stream. They are limited to the water available from the springs. There is to some extent a variety in the character of the soils covered by the main Oregon decree. Under the decree as now drawn, one is entitled to the rate specified in the decree; otherwise it would throw the distribution into the discretion of the water master. (R. 1090, 1091.)

If the use of that amount brought excess irrigation, the other rights would have an opportunity to bring procedure for a further determination. The water master would have no authority to deprive, except where use was obviously wasteful. It is my understanding that the water master does not have judicial discretion to determine these matters. Probably in actual practice there is some give and take in the actual operation of the stream. I understand that

reasonable use is not permanently foreclosed by that decree, but is available for further determination when conditions justify it. (R. 1092.)

As to deep percolation I say it may be either beneficial or detrimental depending upon conditions. It might be beneficial in leaching down injurious alkali salts, and if carried to excess it might be harmful in leaching out available plant food. In this area of coarse soils the tendency would be to leach the soil but not to the extent of depletion. The practice of manuring and cover cropping is based on counteracting deep percolation losses. (R. 1093.)

RE-DIRECT EXAMINATION—HARDING

A reduction of water allowance to less than the water requirements would change the farmer's crop scheme or reduce the grade of his crop, or cause him to abandon some land, and thus change his crop returns. If a 10 per cent reduction is made, his crop production would be reduced 10 per cent. If he must change the character of his crops the change would be one from what he now finds most profitable to something of less profit, and might determine the difference between a profitable farm and an unprofitable one. I don't want my answer interpreted that if they cut the requirement two or three per cent that these dire results would follow, but any substantial reduction would have that character of effect. In general it would be proportional to the cut. The fourth proposition was that they could pump water to supply the deficiency. That is what a large number of irrigators are now doing. (R. 1095.)

I spent six weeks on the Sunnyside project in 1917, determining water requirements under the extension act of the Reclamation Service, for the fixing of operation and maintenance charges. (R. 1095.)

I was engaged to come into the Sunnyside division and make a determination as to what the reasonable requirements were of the different grades of soil which could be

used as a basis for such a classification. My work concerned the determination of those rates of use, and included a study of soil classifications. I determined the different types of soil, went out at the time when they were being irrigated, followed the irrigation, took soil moisture samples, had the soils analyzed, obtained information on their practice as to length of furrow, the flow in the furrows, time of setting the furrows, and other information to determine the reasonable requirement of the lands. I found no soil that I would consider closely similar to the class three soil in and about Milton and Freewater. (R. 1096.)

There were coarse textured soils, (Sunnyside project) many of them of shallow depth, but they do not represent the large proportion of the lands, public lands, some 60,000 acres on which I worked. There are no lands within that area on the Sunnyside division that requires irrigation at anywhere near the frequency of these class 3 lands on the gravel cone. I found their usual practice was from six to eight irrigations per season on the two latter classes of shallow soils, some of which over-lie rock and gravel, but on their sandy soils, not containing gravel, the number of irrigations range from three or four per season on those with sandy surface soil with heavy sub-soil to retard the downward moisture movement up to four or five irrigations per season on similar surface soils lacking a heavy sub-soil. The longer period which those lands are able to go between irrigations indicates their higher moisture holding capacity. I found also on their sandy lands that the average depth applied for irrigation varied from eight to twelve inches at each application. On the shallower lands the depth varied from four to six inches under their usual practice, and the ability of those soils to retain water was sufficiently greater than those on the gravel cone at Walla Walla that they were able to grow alfalfa with much fewer numbers of irrigation than would be required on the gravel cone.

I found no soil there with the loose underlying gravel that would cause as large a downward percolation as this soil. The soil filling materials in their land is of heavier texture than on the gravel cone here. (R. 1097.)

Examination—George H. Carter

(Transcript pages 1099 to 1126.)

I reside at Boise, Idaho, and I am a Civil Engineer engaged almost entirely in irrigation. I went to the University of Nebraska, completed all of the work with the exception of a thesis, had to leave, and am still without a degree. My irrigation engineering experience began in 1908 when I was employed to survey, design, and construct an irrigation project in Southern Idaho. (R. 1099.)

From 1910 until 1913 I was in University. From 1913 to 1915 I was employed by the Bureau of Reclamation on construction of the Arrowrock and Jackson Lake dams, and on project surveys and things of that nature. In 1916 I was employed by the U. S. Geological Survey on stream measurement work. In 1917 I was assistant to the general manager of the Twin Falls Canal Company in Twin Falls County, Idaho, in the operation of a 200,000 acre irrigation project. From 1918 to 1921 I was assistant engineer and chief hydrographer on the Twin Falls North Side Land and Water Project, a large project in Southern Idaho. From 1921 to 1931 I was director of Water Resources and Commissioner of Reclamation for the State of Idaho, a position commonly corresponding to what is called State Engineer. Since 1931 I have been in private practice in Boise, Idaho. I had during that time to study irrigation districts and their use of water and had supervision over and direct charge of about 75 water masters in the State of Idaho. (R. 1100.)

I was in direct charge of all irrigation matters during the time I was Director of Water Resources. (R. 1101.)

I am familiar especially with the use of water upon various classes and textures of soils. The lands in Idaho run

all the way from gravelly lands to very fine, tight textured soils, and there were under my supervision two and a quarter million acres of irrigated lands. The largest and most important irrigation district in the state of Idaho is the Snake River project. At the upper end of the Snake River Irrigation District there are some 60,000 acres of farm lands all on a gravel fan where the Snake River emerges from the canyon and the stream gradient flattens, thus depositing great depths of gravel throughout that area. The water rights on that gravel fan were adjudicated in 1907 and '08 by the Rexburg decree. On the gravel fan the soil in general for the first foot is from 40 to 60 per cent of medium sandy loam, the remaining per cent gravel or small cobbles. In the second foot from 40 to 50 per cent sand, and the remaining percentage gravel. (R. 1102.)

The third foot runs from 30 to 40 per cent sand, and the remaining percentage gravel. From there down the gravel content gradually increases. The soil depths are over 100 feet of this formation. At the beginning of the irrigation season the water table stands 80 feet below the surface on an average and along towards the close of the season it will be about 30 feet higher, representing a variation of about 30 feet during the season. Where irrigation begins the drainage is away from the stream, but as you progress down stream the slope of the ground water table changes so that when you reach the lower end of the section it is a gaining stream. They raise alfalfa, potatoes, sugar beets and grain. I have compared the precipitation tables with the district here. (R. 1103.)

The annual rainfall is similar, but during July and August and September there is an aggregate of three inches more rainfall in that area than in Milton. July and August are the critical months in that area. They use water there from a minimum of 8.7 acre feet to a maximum of 14.83 acre feet. The decrees there average about two miner's inches per acre. The irrigation method is largely flooding; the

heads used vary from three to seven cubic feet per second; the farm areas average from 70 to 80 acres. (R. 1104.)

There is also an area of similar formation, but smaller in size, known as the Upper Wood River Valley. It is around Hailey, Idaho. There are two to three thousand acres of very gravelly land in that project. They use around an average of 8-acre-feet per acre during the three or four months irrigation season. The altitude there is 5200 or 5300 feet. They have a shorter growing season. The decrees there run about two miners' inches per acre. In Idaho a miner's inch is 50 inches to the second foot. In referring to the Snake River lands I was using the Oregon inch; in referring to the Wood River lands I used the Idaho inch, which I commonly use. Translating the Idaho two inches to the Oregon measurement it would be 1.67 inches. I am not as familiar with the soil analysis of the Wood River country. On the surface it appears similar, and also in the ditches and cuts of any kind where the soil is visible. That is the area from Bellevue on up to Hailey and up to Ketchum. In 30 feet it is fifty per cent gravel. There was 70 to 80 per cent sandy loam in the first foot, the remainder being gravel varying in size from pea size to cobbles three or four inches in diameter. The second foot is one-half sand and gravel and clay, and the remaining gravel. The third foot is about fifty per cent gravel and fifty per cent sand, with a small admixture of clay. Their irrigation method is largely flood. (R. 1105, 1106.)

The crops are hay and grain and general farm crops due to the short irrigation season. I think an intensified orchard growth would require more water.

I came here on March 25 and have since been quite industriously engaged in the study of field conditions, or of the various records which are available for consideration. Irrigation practices in general in the valley are quite in conformity with the methods and systems used in other places with which I am more familiar. The method of distribution

of water is common, and I think a well accepted practice. In general the conditions, with the exception of the soils, are similar to other areas with which I am acquainted. I have examined the stream flow records and hydrographs and related data. (R. 1107.)

From my study I think that the method of distribution of water, taking into consideration the soil conditions, the numerous branches of the stream, the nature of the supply of water, is an efficient distributing system under the conditions and circumstances existing. It is a very good distributing system and conforms well to the average practice. It possibly is better than a material number of distributing systems throughout the country.

I also considered seepage losses in the stream system, but did not give a great deal of attention to that. I made my study upon the basis of water delivered at the farmer's measuring gates. I made studies as to the necessity for irrigation frequency of once a week for orchards, and twice a week for tomatoes and short-rooted crops. (R. 1108).

From my general knowledge of soil conditions, crops grown, and the testimony of the various witnesses as to frequency of irrigation required, it appears that the amount of water applied is not more than could reasonably be expected to keep the crops in a satisfactory growing condition. Under the conditions that exist the practice as to frequency of irrigation is a reasonable and beneficial use of water. From my observation, I am of the opinion that the minimum of water that can be applied to these lands in one irrigation is five or six inches in depth. This checks with my experience other places. I have observed that generally speaking five or six inches is about the minimum application under average farm conditions. The application being the minimum, of five or six inches, the frequency will determine the amount of water necessary during any period of time. (R. 1109.)

In speaking of depth of inches I mean acre inches. I visited the test places whose owners have testified here. Studied the record as to use of water on those places, observed the places in detail. I saw that their farming practice was good; that their irrigation appliances and the distribution of water was all that might be expected under general economic conditions, and did not see anything I would consider out of line with good irrigation practice. The test places were, I think, representative of the district. I think the farmers on these places were a good class of farmers. (R. 1110.)

Taking the nine test places, the average use of water during July was 2.52 acre-feet per acre; during August it was 2.09 acre-feet per acre, making a mean for the months of July and August of 2.3 acre-feet per acre, which converted to a continuous flow amounts to 1.49 miners' inches per acre. I consider that delivery efficient under an attempt to deliver one and a half miners' inches per acre, and from all the calculations and observations I can make, I think one and a half miners' inches per acre represents the minimum amount under which these farmers may successfully carry on farming in the gravel area. (R. 1111.)

The distribution of water is quite uniform and as well handled as can be expected. In my calculations I did not use the month of June because there is ordinarily a surplus of water and larger diversions are made then than in later months, and if the month of June is included a higher seasonal use would be indicated than would be the requirement. I wish to make a correction on myself. I did not consider all of the nine test places in my estimates. I eliminated the Bookout place because the soil there is not similar to the other places, which are either gravel lands or lands approaching gravel. Also the right was shut off on the 4th of July, and I could not have a July record. From all my studies I think the water requirement fixed by the Oregon decree is a necessary requirement for the irrigation of the lands

covered by that decree, and is a reasonable requirement, and an amount of water which these farmers must have in order to pursue their farming operations successfully and profitably. (R. 1112.)

On the lands covered in the north part under the springs where the soil texture is finer and the water table higher, irrigation can be accomplished with a lesser application of water; I mean less than one and a half miners' inches per acre. In my experience, the quantity of water available has a relation to the production and prosperity of the project. I observe that with irrigation projects, the general prosperity of the project is quite largely affected by the available water supply. Considering one project in comparison with another the water supply will be a very close measure of that project's prosperity. As the water supply diminishes, land values will diminish proportionately to the available supply which fixes the crop production; so eventually if a water supply is spread out too thin and a man's farm is spread out over too much area, and not enough production per acre, he comes to the point where his taxes and his overhead cost of farming and things of that nature exceed his return. The intensity and diversity of farming is affected by the available supply of water. (R. 1113.)

With a continuous supply of water of a fairly generous proportion it is possible to have diversified cropping so that within a rather wide range he may pursue his own desire in the matter of crop selection, while if the supply is limited there will be two or three crops grown with any profit. Crop yields increase with the available water supply. I noted the crops raised on the No. 3 lands around Milton, and have observed the testimony given with reference to them. From my experience, July and August being critical months for water supply, if the water were decreased below the requirement for raising their crops in the Milton area, that is, decreased some substantial amount, there are several things that would happen. The remaining supply could be applied

to the present irrigated acreage, resulting in a decreased crop yield and decreased quality. On the other hand a portion of the acreage would be eliminated entirely from the area. (R. 1114.)

Again, there might be a change in the crops grown, or as a last resort the farmers might put in more wells and pumps, and at a material cost preserve the amount of water which they find necessary for satisfactory use. The fact that the farmers over this district on No. 3 lands are using substantially 300 wells furnishes an index that the surface supply of water is deficient. Substantial amounts of water are pumped at a compartively high price per acre foot for power, and this proves conclusively to me that the farmers have found a need for that water. It seems to me that it is a general index of the value or necessity of water when farmers pay out large amounts of money for power bills each year. (R. 1115.)

The pumping operations, as shown by Oregon Exhibit No. 42, shows .359 second feet for 9½ acres; to a .727 second feet for 19.7 acres. That represents the amount of water which has been determined as necessary to give an efficient irrigation. In the ordinary use of water by pumping there is a large demand charge which is based upon the peak load of the season. If the load can be maintained fairly uniform, the power bill is thus brought down to the minimum so that the tendency is to hold the use of water or power down to as small an amount as can be successfully applied. I do not think it feasible or practicable for a stream with a flow such as this to make a limitation on water used upon a uniform basis of acre feet for each month. The limitation must be based upon the available supply at the critical months. It would not be permissible or of any value to take the stream flow for the entire irrigation period, six or seven months, average it up and say that the average is the amount that can be beneficially applied each month. (R. 1116.)

If a season's aggregate delivery is to be considered, there should be attached to that a minimum percentage delivery in the months of July and August. A seasonal delivery alone without the percentage available in each month is not a criterion of the value of the water supply. In determining water requirements I considered use records of water upon the land. I think it is of considerable more value than any other information at hand. My experience is that irrigation farmers working under conditions of limited water supply attempting and succeeding in applying reasonable methods, furnished through their conclusions as to the amount of water available during a season are the most reliable guide. I think there is a tendency on one side to approach a theoretical minimum, opposed on the other side by poor or haphazard irrigation farming or just use of water. The problem, as I see it and the theory I pursue, is to reach a reasonable meeting ground between the two extremes. (R. 1117.)

In fixing the duty of water for No. 3 soils, including 2-B soils at one and a half inches per acre, I feel this is a meeting of the extremes for this district. (R. 1118.)

Cross-examination—Carter

In saying that this is a reasonable meeting of the extremes I am stating the problem generally and do not have in mind any specific case. There may be cases in this valley where more water is used. I don't know of them. That is frequently the case in any irrigation project. There will be a few farmers who either attempt to use more water or succeed less with the same amount of water than their neighbor. The use of too much water has no bearing upon the crop yield in any substantial way. There are isolated cases where over-use of water is proven, but it is my general observation and experience, considering irrigation projects as a whole, not farms, that in spite of water logging and alkalining of ground and other things that may be attributed to

over-use of water, still the project of greatest or largest water supply is the most successful. (R. 1118, 1119.)

The area I referred to in Idaho consists of 15 or 20 separate and distinct canal companies in the Upper Snake River valley whose rights are decreed in the Rexburg decree. While I have no average figure for their diversions, I have a number of detailed figures of it. I have them for each canal company as a whole, but not the average for the entire area. They have an abundance of water supplied up to the extent of their decreed rights, but anything beyond their decree is very zealously claimed by down-river rights; the prior rights are up-stream. There are a half-million acres of irrigated lands below watching this area for years, attempting to limit their diversions to as small an amount as possible. (R. 1120.)

I know the Twin Falls project. They use an average of 3.8 acre feet at the measuring weir per season. That is less than the Snake River Irrigation District, but the soil conditions are entirely dissimilar. The crop yield is greater per acre in the Twin Falls district. On the Upper Wood River valley the average use is about eight acre feet per season. Some run higher and some run lower. At one small ranch the diversion was almost twenty acre feet per acre; this would be 150 acres out of 2,000 or 3,000. (R. 1121.)

In general they have an ample supply of water with the same zealous watching that the Upper Snake River has. The storage rights and other rights below do not intend to permit these rights to divert any more water than they are entitled to. Due to crop limitations, climatic limitations, etc., their yield per acre is less than at Twin Falls. Outwardly it might appear that the prosperity of these two projects is less than that of the Snake River project, but the bonded indebtedness, etc., and mortgage debts of the Twin Falls country greatly exceeds the other area. The diversions in these projects are quite similar to this country. There is no cost of acquisition of water rights. Small organizations build sim-

ple ditches to divert the water; they do not have costly works and no storage. (R. 1122.)

The stream system here is used by a great many diversions made by the farmers along the stream without any heavy expense in canals or diversion works. I do not believe that anything economically feasible can be done in the way of improvement of the present distribution system here. It seems to me above the average in its present state. I find no saving appliances other than well-constructed channels, confining the water as much as possible; good concrete control gates and turn-outs where rather rapid adjustments can be made of the supply and the water not spread over the country or running wild. It is pretty well controlled I think, with nothing but earth ditches. (R. 1123.)

My understanding is that a number of rights with good priorities on the river still pump to augment their supply. Most of them that are pumping have later rights from the stream which cannot be used in the summer. (R. 1124.)

Re-direct Examination—Carter

The Twin Falls project is not comparable in any way to conditions upon the cone here, neither in crop selections, crop raised, or soil conditions. The irrigation season is shorter, the altitude is from 4,000 to 3,500 feet; the 8 acre foot average on Wood River is for a four months period. Computed upon the basis of six and a half months period it would run up to twelve and a half acre feet. (R. 1124.)

To a certain extent the ditches here are sealed by silting. They are what we term "shingled," in some places, and where I could see them the bottom of the ditch did not present the appearance of open loose gravel. Their method of cultivating orchards here with cover crops is prevalent in a material part of the orchard lands or areas that I know; I would not say it was dominant. (R. 1125.)

James M. Spencer—Examination

(Pages 1147 to 1156)

I am water master for district number five, State of Oregon, which includes Umatilla, Morrow, and Gilliam counties. The Walla Walla river is in Umatilla County and in my district, and I am in charge of the distribution of water there. Mr. Mason is my deputy. I imagine that I have to spend one half of my time on the Walla Walla river. (R. 1147.)

I spend from two to three days a week here during the summer. I have been administering water here since 1929. For six years before that I was manager of the Lake Point Irrigation district in Medford. I am not a registered engineer, but have studied engineering. I have studied the transportation losses from the red bridge down to the East Side Ditch Company's headgate on the main channel of the Tumalum. In two different measurements I got 13.6 per cent and 14 per cent loss. In one case there was 15.4 second feet at the red bridge, and in the other case there was 13.24 at the red bridge which I measured by current meter. (R. 1148.)

I have experimented to find out how much of a rise and how long continued it should be before we can safely adjust our distribution to take care of it. It depends upon the time. If the permit rights are running—if the Hudson Bay is running and the Pleasant View is running, all of the excess is thrown into them. The first thing we do before cutting any priorities is to limit the old priorities to their actual right. Before we cut off a permit we insure that we have a practical inch and a half delivery to all the older rights, so that there is no over-delivery to the older rights. We have determined by cut and try methods what amount of water is necessary to turn into the various natural channels in order to carry to the diverters from those channels the amount of water decreed to them. The weirs have been checked at least once a year since I came on, and adjustments

made, and the only way you can get at the transportation loss is to take your lower weirs and insure that they are delivering the requirement. (R. 1149.)

If they are not delivering it you must go through and cut your weirs until the lower weir is delivering in proportion. If you tried to deliver from the head the exact amount of water due the ditch, it would not arrive at the lower areas. There is no way to get at what that would be without trying it, and that is the way it has been built up, is by cut and try. In this way we have determined it takes from 17 to 20 per cent, and to the East Crockett it has gone as high as 22 per cent. That check has been made annually. If the water is available we make that allowance for the East side ditch. I assisted in checking to ascertain the exact acreage decreed, and eliminated from the West Crockett, the East Crockett, the Stillman, the Ford, the East Side ditch, the Powell, the Perkins, and the Tumalum ditches. Perry and Mason helped. We checked our decree and the list we had made before against the list we were making up. We referred back to the maps. We had our decree adjudication map and delivery sheets. The figures were turned over to Mr. Humphrey. We do not start measuring water from the river when there is a surplus over and above all rights on the Oregon side. When it is cut down so that there is no surplus we start measuring water. When the stream falls enough so that all priorities cannot be supplied we start eliminating priorities. (R. 1150, 1151.)

If we must eliminate priorities upon the Ford branches, it takes from three to four days, and upon the Crocketts it takes about the same. Mason does that; I have left it to him. I would not attempt to work over the delivery system unless the increase in flow was over ten second feet in the summer time. If it is, we—as a rule—cut it into the Hudson Bay. If there is a definite and sustained rise in the stream we would not continue to do that. The Hudson Bay would not accept it, because it would cost too much to take care of it, and we

have no other right to use it on except to distribute it in our own systems. If the rise continued only for a day or two, I would not pay any attention to it. (R. 1152.)

I would not make any adjustment for it. If a depression continues only for a day or two I pay no attention to that; in fact we let a depression last considerable before we make a cut. After the measuring season starts we turn no river water down to supply the water rights on the spring branches below the gravel fan. Some gets through for that purpose, but we do not turn any down for that purpose. The river water is used to supply the rights on the gravel fan and above, and to the Pleasant View and the Hudson Bay during the time their priorities can hold it. (R. 1153.)

The Spring branches are separately administered and are distinct from the main river. (R. 1153.)

Cross-examination—Spencer

I checked the loss of the main stream between the red bridge and the East Side ditch on July 13, 1932. I also metered the stream at the red bridge on July 11, 1930. The stream at that date at the red bridge was 13.24 second feet. The pumping plant at the cemetery was using one and a quarter second feet. Below the swimming pool I had 13 second feet. At that time there was apparently enough seepage back from the Little Walla Walla to off-set the pumping plant of the cemetery. I measured the Tumalum ditch delivery, (the nursery was not pumping at that time), and the East Side delivery; and there was a loss of 1.8 second feet between the point where I measured last and the final delivery to these two channels. (R. 1154.)

There was no other delivery. On July 13, 1932, I metered the Tumalum river—15.4 second feet; I metered the Tumalum ditch—2.3 second feet; the East Side ditch—10 second feet; the Miller Nursery was pumping one second foot. There was a loss of 2.1 second feet. Both times I measured

it, water was being diverted through the Little Walla Walla, and only a very small part going down the river. I can't say certainly, but I don't think the Hudson Bay was diverting any water at the time. (R. 1155.)

At that time these measurements were made, the East Side ditch was measured below the railroad bridge, at the old weir. There is a new weir there now, just above the railroad track; that is, the diversion is above the railroad track and the weir is just below the railroad track. (R. 1156.)

The foregoing is respectfully submitted,

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